AGRICULTURAL ENGINEERING

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CONTENTS

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The Relationship Between Engineering and Home Economics[1]

By Grace L. Pennock[2]

I AM going to discuss with you the relationship between engineering and the home, a relationship brought about by the industrial type of civilization toward which this country is directing its energies. The home needs the engineer. The need of the engineer and all other people in this country for the home we must take for granted. Unless the home is going back to the days of hand-drawn and hand-carried water, of candle light, of inadequately heated houses, of home spinning and weaving and a diet limited to local products, the engineer must play an increasingly important part in the picture.

The engineer utilizes the findings of science and the genius of the inventor in making products which are used in the home. Without the engineer, discoveries in many fields would never reach a form in which they can be used by masses of people. Results of the inventor's genius would fail to come down to earth in economic and usable form. Science and invention have joined hands in the engineer, who by intelligent and patient work has combined the results of invention and scientific research.

Engineering has been well defined as "science which works." Supported by the capitalist, the industrialist, and the scientist, the engineer has changed the entire character of civilization. He has brought us from an agricultural to an industrial age. Not all the results of this have been good, but I believe we are not going to turn back. The errors must be corrected so that the future will see life simplified, not complicated, by the engineer's work, so that there will be a richer, fuller life for all partly because of him.

In this march of progress the home has met with many changes. The hand of the machine age is in evidence at every turn, except in strictly primitive homes. Where the work of the engineer and the industrialist has been utilized, housekeeping—which is the part of the homemaking job that has to do with the mechanics of living—is not a physically difficult task. Power in one form or another takes the place of human energy. Hot and cold water runs at the sink, and runs out again. Pumping is done by other than human energy. Carrying and lifting water for cooking, dish washing, washing clothes, and bathing has been eliminated.

The washing machine, power operated, replaces scrubbing of clothes—a back-breaking job that many women are physically unable to endure. Ironing—much of it at least—can be done sitting comfortably at a machine which is operated with little expenditure of human energy. Hand ironing, what little is still necessary, has been robbed of its more difficult aspects by utilizing electricity for heat. The heat from a kitchen stove and the endless journeying back and forth from stove to ironing board to keep irons hot have been eliminated.

The vacuum cleaner takes the place of the beater and the broom. Carpets and heavy rugs no longer have to be carried from the house to outside clothes lines for periodic cleanings. The broom no longer creates a dust in frequent sweepings. The vacuum cleaner with the use of only a very little human energy keeps the floor coverings clean without scattering dust over the the room to be wiped off later. Easily controlled fuels and modern ranges provide heat for cooking without producing 100-deg kitchens as a by-product. Refrigerators replace trips to the spring house, the cave, or the cellar, and food is kept in them safely for days, thus aiding not only the food storage problems but the marketing and cooking problems as well.

Mixing machines speed up the cooking and make it far less wearisome than it was. Dish-washing machines ease a tiresome process which is ever present. The electric sewing machine replaces endless hand stitches, without even the foot pedalling of a few years back.

Water systems, sanitary systems, central heating plants, and electric lights have added a tremendous measure of comfort to the entire household and have relieved the housewife of much unpleasant drudgery, adding hours of leisure to her days and sometimes years of life.

I have spoken thus far

[1]An address before the 27th annual meeting of the American Society of Agricultural Engineers held at Purdue University, Lafayette, Indiana, June 1933.

[2]Household appliance specialist and editor, Delineator Magazine. Assoc. Mem. A. S. A. E.

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only of the bright side of the picture. There is another side to the story. There have been errors which should be avoided in the future. The engineer, the inventor, the industrialist have frequently ignored the fact that after all a woman and not a man is going to use the equipment they manufacture. They have made devices for her to use without full knowledge of her needs. Because their products relieved her of so heavy a physical burden, the woman has bought them whether they were as good as they should be or not. Many things have been made because they would sell. That is not a charge against them, but their makers have been short-sighted in not learning more about the needs of the woman. Manufacturers have made many mistakes costly to themselves, and woman's needs are not as well provided for as they should be, and could be, if more thought had been given to them.

The home economist, the woman trained in science and experienced in homemaking, knows what the woman in the home needs. If the engineer is to make his applications of science and invention work to the best advantage, he needs the assistance of this trained woman. Industry and engineers have partially recognized this need. Your speaker would not be here today if this were not true. Industry today frequently employs the home economist to work with the engineer, but a more frequent tie-up between these two is needed to insure the most rapid progress in creating efficient labor-saving equipment for the home.

The need for this combination becomes evident when concrete examples of mistakes are considered. Take the seemingly simple matter of cooking utensils. The modern ranges, gas and electric, have shown a need for utensils which would heat food quickly and efficiently. Fuel economy has become of greater importance than it once was. The fire is no longer kept going continuously in the range. The tea kettle of water is not kept boiling continuously. Water for cooking is heated as it is needed, and it is often wanted in a hurry. Pans no longer need to set down through a lifted stove lid to be close to the flame, hence the need for the deep narrow-bottomed pans has gone, that is, where modern cooking conditions prevail. This has brought about the flat-bottomed, straight-sided pan with a larger area in contact with the stove top so that it will heat quickly. Materials for pots and pans which clean easily and which will heat quickly have become important matters. Dirt-catching crevices and hard to clean edges are no longer acceptable. Pots and pans have gone through a great evolution and not always for the better, but they are on their way to better things and have shown tremendous progress already.

Errors in Design Are Costly to Both Maker and User

One manufacturer made a serious error in handles for cooking utensils. He apparently gave a designer free reign. Good looking pans resulted. A metallurgist produced a metal alloy of supposedly superior qualities for these pans. They appeared on the market at a good price; this was within the past five years. They disappeared in about two years' time so brief was their life. The handles of these pans were made of an insulating material joined to the pan by a metal section. It was intended that these pans be handled without a holder, but this cool part of the handle was too short. In order to lift the pan with food in it one had to grasp the handle close enough to the pan to come in contact with the metal part of the handle which was hot. Thus a serious burn resulted. No good looks could possibly offset this difficulty. I knew personally one or two who purchased these pans and threw them away because they were really dangerous to use. A pan with an all-metal handle which needs a holder can be used easily and safely. You expect to watch out for it, but this partly insulated handle throws one off one's guard. And then the metal of which these pans were made did not prove very desirable because it pitted badly in hard water, another great drawback to an extremely good-looking pan.

Another case was with stainless steel pans. Some of the earlier pans of this metal warped so badly when they were heated that they made contact with the cooking surface at only one small place. This made these pans inefficient in heating. It was also very unpleasant to find one's pan twirling around at various angles because of its warped bottom. Such an inconvenience could never be offset by ease of cleaning or good appearance. These pans had to be changed to stay on the market. If they had seen practical use in the first place, they would not have been sold until these difficulties were corrected. Manufacturers would have been saved expense and a loss of goodwill from those who bought. And some customers would not now have useless pans on their shelves, and a grudge toward those who made and sold them.

The Problem of Adjustable Heights an Important One

While we are on this question of pans, another point about handles comes to mind. Some of them have been made with no thought for the size of the hand to use them. These found only a limited market. Some were once made with wooden handles fastened to the metal by means of a rod through the wood part. When these became worn with use, the wood part which you grasp turned around on the center rod and allowed the pan to tip over in your hand. A very simple device corrected this difficulty but this defect never should have existed. In fact, a good many kitchen utensils are put on the market with some major defect, because the designer and the engineer did not know just what these utensils would do in actual use. The inventor, the scientist, the engineer cannot work advantageously without the help of the home economist.

Designers and makers of kitchen cabinets, work tables, washing machines have not entirely solved the problem of adjustable heights. Some equipment is adjustable, but this is the exception rather than the rule. Do you know what it means to work at a table three inches too high for you, or at a sink four inches too low? It means back aches, stiff shoulders, many wearing hours that could be avoided. Because women have not all been made the same size, nor with the same proportions, equipment standardized in height will not suit them all. Equipment should be adjustable in height.

On washing machines obvious needs are wringer releases which operate easily and safe electrical equipment. These are not always what they should be, even yet. Simpler matters like complete and rapid draining are frequently overlooked, and these are important matters to a busy housewife. Very serious is a design in the washing device which actually wears and strains clothing so that holes appear after a short washing period. Rough agitators of improper design have had to be remedied at great cost to the manufacturer. Experiments in actual laundry work under eyes of a competent person when these machines were being designed would have detected such difficulties before they caused the manufacturer embarrassment.

A small electric mixing machine which once came to the Delineator Institute was provided with a hook for mixing bread. Literature accompanying the machine listed bread making as one of the machine's accomplishments. But evidently the designer of the machine was not at all familiar with the nature of bread dough. The motor of the machine would not stir a mixture as stiff as bread dough, nor was the mixing bowl provided large enough to make a quantity of

bread such as is usually made even in small families. This device was a total loss to all concerned.

Coffee pots have frequently appeared with coffee baskets holding too little coffee for the water capacity. The engineer, or whoever determines these sizes, should be guided by someone who knows what quantity of ground coffee is needed for really good coffee. Another point in coffee pot design is the opportunity usually allowed for coffee aroma to escape through the spout. A coffee pot which prevents this escape of aroma will provide the best coffee at the table.

Cooking thermometers are often hard to read. Some have the glass so insecurely attached that incorrect readings are frequently made. Such thermometers are worse than useless.

Electrical equipment is subject to many errors—often because of lack of knowledge of what such equipment is expected to do. Waffle irons of good quality sometimes cook waffles much darker on one side than on the other. In designing these, allowance must be made for the fact that waffle batter is placed first on the lower grid and some seconds frequently elapse before the top grid comes in contact with the mixture. This loss of time must be made up for in additional heat in the upper grid.

Even good quality table stoves, toasters, sandwich toasters, and percolators frequently lack insulation at the points necessary to protect table tops and fingers, usually through no intent on the part of the designer and manufacturer, but because they have failed to realize what temperatures were undesirable at various points. These are but a few of the examples of poor judgment in designing household equipment. Many more could be cited, but these will serve to show what sort of relationship should exist between the man who plans the details of household equipment and the woman who is to use it. A woman trained in science and its applications who has had experience in household matters should be the go-between here. Without the engineer and the inventor the woman in the home would be without much that makes her work easy and her life richer but even better opportunities can be hers when the engineer understands more fully just what is needed in the home. The home economist can say what is needed, but it rests with the engineer to work out how it can be done.

The Designer Should Be Familiar with Kitchen Processes

One must be familiar with kitchen processes to know how long it takes and how much work it is to do things by hand or by simple hand-operated tools before one can design power-driven substitutes that will really be useful. Mixing and beating small quantities and extracting the juice from two or three oranges is frequently done more quickly with a good hand-operated egg beater and a ten-cent-store reamer than it is with the power-driven equipment, when you take into consideration the time for assembling it and the cleaning-up process. It takes experience and judgment to know where and how the household processes can be simplified and be made easier. Equipment that is difficult or time-consuming to assemble is useless. It will be used a few times only. After that it will find a place on a high shelf out of easy reach along with other occasionally or never used articles—a mute reminder of an expensive mistake.

It is not only the equipment which goes into the kitchen that is important. The house itself, its plan of rooms, and the arrangement of furnishings and equipment are very important in making the home attractive to live in and efficient to work in. The kitchen is one of the most important rooms to consider, if the housewife is to do her work efficiently. Its size and shape, the arrangement of the large pieces of equipment, and the grouping of the small articles around the work centers determine how many hours the housewife will spend in the kitchen and how easy or how physically difficult those hours will be.

The amount of walking which can be saved by proper kitchen planning is well shown by a study of kitchen sizes and arrangements which was recently made at the Delineator Institute. A study of this nature is closely allied to the work of the industrial engineer. He studies the work processes, routing of materials, arrangement of work benches and their dimensions, as they affect the workers efficiency. The kitchen arrangement study which I made applies the principles of efficiency to the kitchen and its work.

Eighteen kitchens were studied in the entire project differing in various details of size, shape and arrangement. The first room studied was 12x12 ft in size. It was completely equipped with refrigerator, modern range, dishwasher sink, cabinets, serving table, and suitable small articles. It was a modern kitchen and as present standards go was well arranged and easy to work in. By changing the size of the room and the relation of the large pieces of equipment to each other, doing one thing at a time of course and using exactly the same work processes for every test, a far more efficient size and arrangement of room or work center was derived—one which saved over half the travel required in the first kitchen and 15 per cent of the time needed for the day's work. This second kitchen was 8x10 ft in size, but even more important than its actual size was the arrangement of the equipment.

Number of Workers Should Determine the Size of Kitchen

I have frequently used the term "work center" rather than kitchen in referring to this second room, with a purpose. I do not believe that a kitchen 8x10 ft in area will satisfy every woman. What it will do if rightly arranged is this: It will provide an efficient place for one person to prepare meals, cook, and wash dishes. In many kitchens two people work as a rule. There should be additional room and a larger work area if a second worker is present frequently. This can be provided by increasing the dimensions of the room one or two feet each way. The room will still be reasonably efficient for one person. If a much larger room is to be used this 8x10 ft work center can be arranged in a part of it. Additional work space can then be provided elsewhere. Or the rest of the room can be used for dining purposes, for a laundry, or for whatever else is needed. But I want it remembered that the 8x10 ft kitchen is the result of a study to determine an efficient work center primarily for one person.

Not all rooms now in existence can take the exact form which this work center calls for. But by using the same relationship of the larger pieces of equipment to each other as that used in the 8x10 room shown, reasonably efficient kitchens can be arranged in varying situations. For instance, the exact reverse of this kitchen will be nearly as efficient as the plan shown. Interchanging the positions of sink and range will also give good results.

There is much in this study which should interest the architect, the kitchen cabinet maker, the engineer, and the man who puts up his own kitchen shelves and storage places, as well as the manufacturers of all kitchen equipment. It has, for example, brought out the importance of having one-door refrigerators available with doors opening either way, stove ovens either on the right or left, dishwasher sinks the same way, for the greatest efficiency is obtained only when these details are correct and when small equipment is properly grouped around these larger items.

Perhaps you are wondering how all of this concerns the agricultural engineer. I have discussed the engineer who works with the designers and makers

(Continued on page 308)

Utility Refrigerators for Farm Use[1]

By James R. Tavernetti[2]

THE name "utility refrigerator" has been arbitrarily selected to mean one in which the farmer may store relatively large quantities of food for home consumption, either grown on the farm or purchased, and in which he may also store a limited quantity of products until ready for market. This type of refrigerator is probably the most suitable for the largest number of farms, but it has only been during the past few years that any work has been done in designing a suitable cabinet. At the present time there are a number of commercial refrigerators on the market which could be used as utility refrigerators, but their cost is prohibitive to the average farmer. As a result, it is necessary for the farmer to either construct it himself or have it built to order.

The design and construction of these refrigerators present a number of problems which can be solved only by analyzing the requirements which must be met.

Meat in relatively large quantities is the principal product stored on practically all farms. The farmer likes to do his own butchering or buy meat in large amounts, if he has facilities for preserving it until it can be consumed. Usually a lamb, hog, veal, or quarter of beef is the maximum quantity stored, but on some farms it may be desirable to have storage space for a whole beef.

The small foods, such as butter, eggs, milk, and leftovers from meals are the next most important products which must be taken care of. Although the space required for storing these foods is relatively small, it should be conveniently located and have sufficient shelf area.

Fruits, vegetables, and berries are stored on all farms, but the quantity varies widely. Usually a space large enough to hold one or two boxes is sufficient.

On some farms it is desirable not only to store food for home consumption, but also a limited quantity of products for market. Certain products such as eggs, cream, and berries, which are collected each day in insufficient quantities for marketing until several days' supply has accumulated, may be stored and held in first-class condition so that the farmer may obtain the best price for them.

Facilities for making ice are desired on practically all farms, particularly by the farmer's wife, who not only wants cool beverages, but also likes to make frozen desserts. However, ice-making facilities in these refrigerators require extra equipment, and it should be optional as some farmers may feel that the extra expense is not justified.

When ice-making is not provided, some means of cooling drinking water should be substituted. Although this can be accomplished by placing a container in the refrigerator, it is more convenient if there is a coil in the cabinet which can be connected to the water main and to a faucet on the outside. This makes the water easily obtainable, and since the coil is automatically refilled when water is withdrawn, it insures a constant supply. The size of coil necessary will vary with different farms, but will usually be satisfactory.

Because odor-giving and odor-absorbing foods are both stored in the refrigerator at the same time, compartments for keeping these separate are desirable. However, separating the refrigerator into compartments increases the expense and complicates the construction. When ice-making facilities are provided, the coil must be in a separate compartment from the main storage chamber. This usually provides a small storage space which can be kept at a temperature below freezing.

The size of the refrigerator depends upon the quantity of products to be cooled. On farms where only products for home consumption are stored, a refrigerator with 25 to 50 cu ft capacity will usually be satisfactory. On farms where relatively large quantities of fruit, berries, and vegetables are stored, or where products are stored for marketing, a refrigerator of from 75 to 150 cu ft will meet the requirements.

The type of refrigerator, whether non-walk-in, walk-in, or semi-walk-in, is dependent upon the size. Sizes from 25 to 70 cu ft should be of the non-walk-in type. This type of refrigerator is the most convenient for placing and removing products and for dividing into compartments, but is the most expensive per unit volume because of the number of doors necessary.

Sizes from 70 to 100 cu ft should be of the semi-walk-in type. This is a combination of the non-walk-in and walk-in type, and has the advantage of having a large storage space accessible through a walk-in door and a small shelved portion accessible through a small door.

Sizes from 100 cu ft up should be of the walk-in type. This type has the advantage of being able to make the refrigerator as large as desired, but has the disadvantage of having to open a large door to place or remove the products.

Building the refrigerator of sectional construction so that it can be easily taken apart for transporting is desirable on practically all farms. Many farms are rented, and if the farmer moves to another place, he will want to take the refrigerator with him. Sectional construction also makes it possible to construct the refrigerator in a convenient place and assemble it where desired, and also, if it is built to order by a manufacturer, it is more easily shipped and handled.

Refrigerators are composed of two main parts, the refrigerating unit and the cabinet. Ordinarily it is not possible for the farmer to construct his own refrigerating unit, and it must be purchased. The cabinet, however, may be constructed by the farmer, and there are many who desire to do so because of the saving in initial cost. If he is skilled in carpentry, it is practical for him to do the job providing he has definite plans to follow, and uses the proper materials. There is a tendency, however, to cut down the cost by using cheap materials, particularly for insulation, and this usually results in a refrigerator which deteriorates and decreases in efficiency. As a result the proper temperature cannot be maintained in the refrigerator, and the blame, usually, is placed on the refrigerating unit, instead of on the cabinet.

The prime requisites for an efficient cabinet are as follows:

1 *Good lumber.* First-grade lumber that is straight and dry. The extra cost of good lumber is very small in comparison to the total cost of the refrigerator and it more than pays for itself by the better job it makes. Wood which gives off a strong odor should not be used on the interior. Spruce is probably best for this purpose, but it is not always available and other varieties may be used.

2 *Good insulation.* By a good insulation is meant one which has a low heat-transfer factor, is easily

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[1]Paper presented at a session of the Rural Electric Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, Lafayette, Indiana, June 1933.

[2]Associate in agricultural engineering, University of California. Assoc. Mem. A.S.A.E.

moisture-proofed and installed, does not deteriorate, and is easily obtainable at a reasonable cost. For refrigerators under 125 cu ft in size, the equivalent of 3 in of sheet cork should be used for insulation; above 125 cu ft, the equivalent of 4 in.

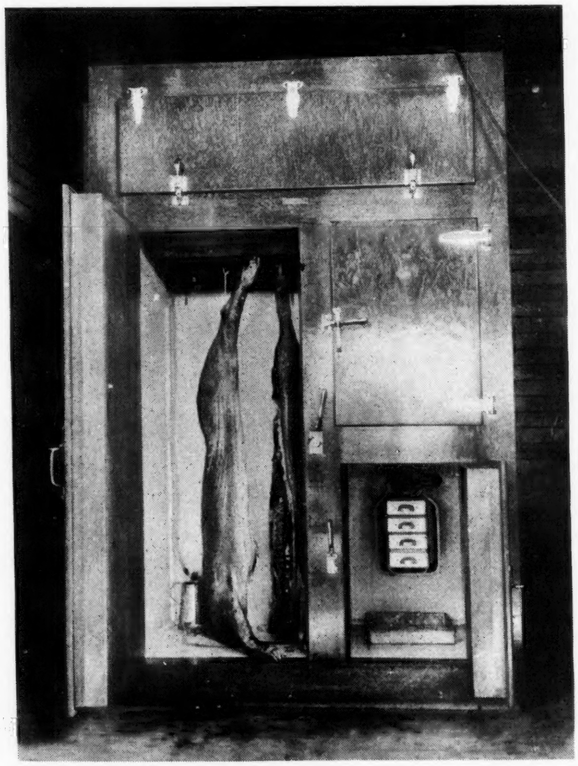
3 *Proper air circulation.* This requires the correct baffle and clearance design. If there is insufficient circulation, meat molds and spoils quickly even though cold. Too much circulation results in excessive drying out of the foods.

4 *Good doors.* Refrigerator doors being heavy and subject to hard usage, must be extra well made. Poor doors are apt to warp or lose their shape and consequently are hard to open or close, and allow air leakage. It is, therefore, recommended that the doors be purchased from a manufacturer familiar with refrigerator construction and not be made by the farmer.

5 *Ease in cleaning.* There should be as few corners and cracks as possible for bacteria to collect in and the finish should be such that it is easy to wash. Shelves and bars for meat hooks should be removable, both for cleaning them and the cabinet.

6 *Careful workmanship.* Although the best materials may be used, good workmanship in constructing is necessary to make an efficient, neat cabinet.

The question most commonly asked by the farmer either in purchasing a complete refrigerator or only the unit is, "What is the best make?" Unfortunately this question cannot be answered, but it is not of great importance. At the present time there is probably very little difference in the performance of the various makes of units although some may possess features which are superior to others. What the farmer should be mainly interested in is to obtain the proper size unit and one on which service is readily available. Too small a unit will not maintain the proper temperatures and will operate excessively, thereby increasing the operating cost and wearing out the compressor more rapidly. Service on the unit is important because ordinarily the farmer is not familiar with how it operates, or hasn't the proper tools or replacement parts, for repairing it.



A non-walk-in type of utility refrigerator suitable for farm use. It has a large meat compartment on the left, a shelf compartment on the right center, and a compartment with an ice-making coil on the lower right. The main cooling coil is across the top. It has a total storage capacity of about 50 cu ft

The operating cost of the refrigerator is a minor item on most farms. It will usually be less than five dollars per month, and this is more than made up by the food saved.

The initial cost, however, is the principal reason why more utility refrigerators are not in use, and the reduction of this cost is the main problem yet to be solved. The price of these refrigerators ranges from \$500 to \$1000; and since the benefits resulting from it are rather intangible, it is difficult for the farmer to see how this expense can be justified. However, when compared on a basis of cost per unit volume, they are considerable less than the small household type. The latter range from \$25 to \$50 per cu ft, while the utility type range from \$5 to \$20 per cu ft depending on the type, size, and whether it is readymade or built by the farmer.

The foregoing has been a theoretical discussion of the problems in the design and construction of the utility refrigerator, and the following is an illustration of the use that may be made of one on a farm.

In 1930 the California Committee on the Relation of Electricity to Agriculture constructed a 50-cu ft non-walk-in refrigerator which was tested in the laboratory and then placed on a farm where observations were made for a period of one year. The interior of the refrigerator was divided into three compartments, one in which as much as two sheep or hog carcasses could be hung, one in which there were two shelves, and one in which a coil capable of making 13 lb of ice at a time was located. The main cooling coil was across the top and the walls were insulated by 3 in of sheet cork with tongue-and-grooved lumber on either side. With the exception of the front including the doors which were purchased made to order, the cabinet was constructed by a local carpenter. It was equipped with a ½-hp air-cooled compressor.

The initial cost was approximately \$800 for the complete refrigerator, of which approximately \$500 was for the unit and \$300 for the cabinet. Of the \$500 for the unit, \$125 was for the ice-making coil and necessary valves for connecting it.

The family on the farm on which it was placed consisted of the husband, wife and four children ranging in age from four to fourteen years. The cabinet was located in a room on the west side of the house opening onto the back porch, and the compressor was located under the house.

The following is a summary of the results obtained. The total quantity of meat stored during the year, which consisted of lamb, veal, beef, venison, turkey, and chicken, was 1713 lb, or an average of 143 lb per month. The total quantity of milk and other liquids stored was 288 gal, or an average of 24 gal per month. The quantity of other foods, such as eggs, vegetables, fruit, berries, and left-overs stored, was 2280 lb, or an average of 190 lb per month.

The door on the meat compartment was opened an average of ten times per day, that on the shelf compartment twenty-five times, and that on the ice-making compartment nine times. The doors were opened the greatest number of times during August, when the average for the three doors was 105 times per day, and the least number of times in December, when the average for the three doors was fifteen times per day.

The temperature in the meat and shelf compartments varied from 29 deg F in the winter to 38 deg in the summer, the average for the year being 33 deg.

The temperature surrounding the cabinet varied from a monthly average of 48 deg in December and January to 82 deg in July. The average for the entire year was 67 deg.

The compressor operated from a minimum of 7.1 per cent of the time in December to a maximum of 31.5 per cent of the time in July. The average operating time for the year was 17.8 per cent.

The power consumed varied from 28 kwh in December to 121 kwh in July. The total power consumption was 802 kwh for the year. Because an electric range and water heater were used on the farm, the power for the refrigerator was obtained for 1½ c per kilowatt-hour, making the operating cost $12.00 for the year, or an average of $1.00 per month.

No repairs were necessary during the year.

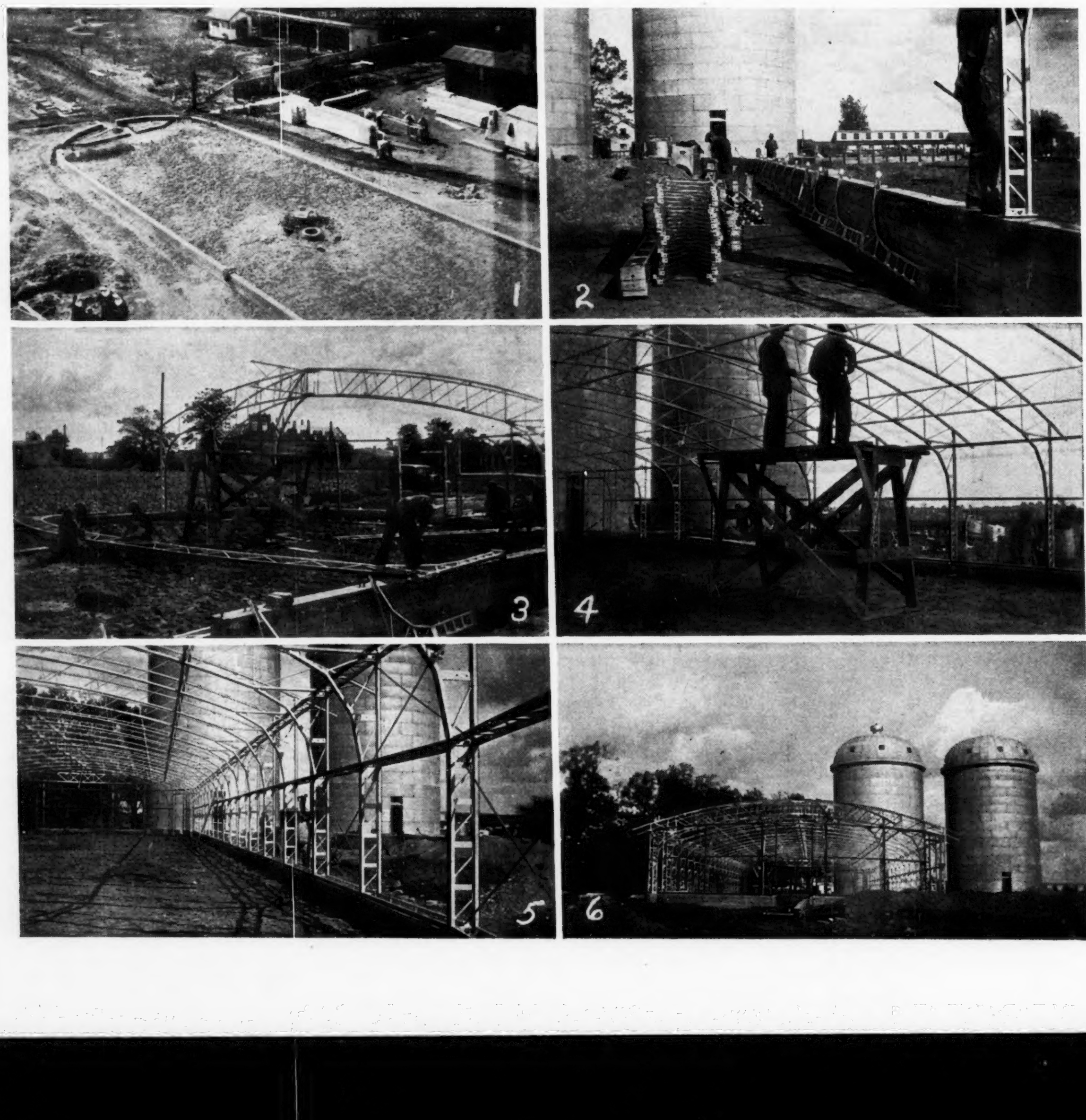
Practically all of the food stored was consumed on the farm, although occasionally a neighbor would store a piece of meat. With the exception of one or two pieces of beef bought wholesale, all of the meat was slaughtered by the farmer and although sometimes held as long as six weeks, none was wasted through spoilage.

The use made of the refrigerator on this farm may not be typical of all farms, but it does show the possibilities for saving and for improving the living conditions.

In conclusion it may be stated that while the utility refrigerator is not used to a very large extent at the present time, it is both desirable and necessary on a large number of farms. If the initial cost can be reduced, and if they are advertised and an effort is made to sell them, more will be used.

NEW DEVELOPMENT IN FARM BUILDING CONSTRUCTION

The pictures on this page show the progress of erecting the framework of what appears to be the latest development in farm building construction; it is a 240-ft, steel-frame barn. (1) Foundation wall ready for the frame. (2) This shows the start of erecting the framework, 7:00 a.m. (3) A truss going up every 15 min. (4) Staging used on the work. (5) Nearing the finish. (6) The same day, at 5:00 p.m.—frame work completed. Insulation in three sizes, cut to fit between any set of trusses, is secured by means of clips. Metal sheathing for both exterior and interior, also standardized, can be put in place quickly. Windows and doors assembled with their frames are interchangeable and need only to be set in place. (Another barn of the same size has now been erected to the right of this one.) In the background are shown two ventilated steel crop containers. In each is an inner compartment for ensilage; in the outer compartment is stored chopped alfalfa or other forage. In the outer compartment is provided an efficient means of ventilation, which makes it possible to store chopped alfalfa a few hours after it has been mowed, and to preserve the palatability (color and aroma) of newly mown hay. These structures are a development of the James Manufacturing Company



Electric Heat for Curing and Storing Sweet Potatoes[1]

By E. T. Swink[2]

THE curing and storage of sweet potatoes has proven to be a sound economic practice, which makes the potatoes available over a large portion of the year and eliminates the necessity of selling the crop as soon as harvested when the price is often the lowest.

For many years the common practice of the farmer was to store his own supply of sweet potatoes in a dirt hill, and this method is still widely used for home storing. Not many years ago curing houses were designed and built for the curing and storing of sweet potatoes on a larger scale, so that the crop could be held for a higher market price. Some large houses were equipped for heating with steam, but the average storage house used a wood or coal stove for producing the necessary heat.

The curing of sweet potatoes consists of removing approximately 10 per cent of the water from the potatoes by dehydration. It has been found that a room temperature of 80 to 85 deg F will cure the potatoes in ten days to two weeks. The potato will begin sprouting the least bit, and its skin will not rub off easily when it is properly cured. The length of the curing period depends much on weather conditions and the ventilation of the house. All the ventilators are kept open during the curing period so as to drive off the moisture-laden air. When the potatoes are cured, the floor ventilators are closed and the room temperature is gradually reduced to 55 deg F. Heat must be provided if the temperature drops below 50 deg, and if it exceeds 55 deg, it can be reduced by opening the floor ventilators.

Except under unusually mild weather conditions, farmers anticipate losing and do lose 10 per cent or more of their stored sweet potatoes, either by chilling in the bottom of the house or by rotting from overheating in the top tiers, when a stove is used for heating. It is almost impossible to prevent a difference of at least 10 deg in the temperature at the bottom and top of the curing house when a stove is used for heating. Obviously the potatoes in the bottom are not thoroughly cured and are therefore more susceptible to chilling. Or, if they are cured out, the potatoes in the top will be overcured. Either of these two conditions result in a loss of potatoes and an increase in the unit cost of curing those that are salable.

In attempting to find some method of heating a sweet potato house to obtain a more uniform cure and prevent the usual loss of potatoes, a farmer near Suffolk, Virginia, suggested using electric heaters, placing them on the floor under the stored potatoes. Representatives of our company cooperated with him and obtained some old electric street-car heaters for the purpose of studying the possibilities of using electricity as a source of heat for curing and storing sweet potatoes. The curing house used was 14 by 18 ft and had a capacity of approximately 700 bu of potatoes stored in crates. It was of wood construction with insulated walls and ceiling. The crates were racked on a false floor leaving an air space of 8 in between the floor of the house and the potatoes.

Twelve of the street-car heaters were distributed over the floor. The heaters were connected in series groups of four, and were operated on 220 volts, each heater having an output of about 440 watts. The total output was 5,280 watts. By using the space made available by the elimination of the stove, 750 crates of potatoes were placed in the house. The curing period was eleven days and the heaters operated satisfactorily, maintaining the proper curing and storage temperatures.

Approximately 18 per cent of the potatoes were lost due to overheating in the bottom of the house, not enough air space having been allowed between the heaters and the potatoes. Although this loss was high, the heaters operated satisfactorily and the current consumption indicated that there were good possibilities of obtaining satisfactory results economically.

Three sweet potato curing houses in the territory served by our company used electric heat for curing and storing sweet potatoes in 1932. Information obtained from the experimental house in 1931 was used as a basis in planning the use of electric heaters in these curing houses. This paper will endeavor to show the plan followed in each house and the results obtained.

House No. 1. The experimental house located near Suffolk, Va., was again operated in 1932 using the twelve electric car heaters in conjunction with a wood stove. The stove was used during the curing period to reduce the cost of curing, and the electric heaters were used along with the stove to insure the curing of the potatoes in the bottom of the house. A false floor was raised to 10 in above the floor and a continuous tin baffle was placed over the heaters. A 5-in air space separated the baffle from the false floor. The baffle served to distribute the heat evenly, and the air space above the baffle allowed a circulation of air between it and the potatoes. The curing period lasted ten days and every potato in the house was cured perfectly.

The heaters consumed 174 kwh of current during the curing period and 934 kwh during the storage period, which was from October 20, 1932, to May 1, 1933. Electric heaters furnished practically all of the heat for the storage period, the stove being used for a very short time only on one or two occasions. The 700 bu of sweet potatoes cured required 1108 kwh of current for curing and storage, or approximately 1.6 kwh per bushel. There is no reason to believe that the electric heaters alone would not have given as good results as were obtained by using a stove in conjunction with them. The reason for using the wood stove was merely to reduce the cost of curing.

House No. 2. This house was located near Norfolk, Virginia, and is built of cinder blocks according to the specifications furnished by the agricultural extension division of the Virginia Polytechnic Institute. The house is 20 ft by 40 ft and has a capacity of 2,000 bu of potatoes in crates, or 2500 bu in bulk. This season 2500 bu were cured, most of which were stored in bulk in the ventilated bins. The false floor in this house was 8 in above the floor, leaving an air space of nearly 9 in. Sixteen 500-watt electric-strip heaters were connected in parallel on 220 volts with a thermostat in the circuit. Two of the heaters were placed over each of the corner floor ventilators to heat the air as it entered the house.

Weather conditions for curing the potatoes in this house were about the worst possible. The potatoes were wet when placed in the house, and there was

[1]Paper presented at a session of the Rural Electric Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, Lafayette, Indiana, June 1933.

[2]Agricultural engineer, Virginia Electric and Power Co. Jun. A.S.A.E.

much rain during the curing period. The current was turned on November 2, 1932, and the curing period lasted 16 days. Eight days were required to bring the temperature of the house from 60 to 80 deg, due to the cold wet weather outside and the wet condition of the potatoes. The outside temperature was 52 deg when the curing period began and continued to be around this temperature throughout the period. After the rainy period was over, the weather turned cooler with heavy frost; however, the inside temperature of the house remained fairly constant.

The connected load in the cinder block house was 8 kw and 3000 kwh of current was consumed during the 16-day curing period. Only 100 kwh was used during the storage period. A great deal less current was used in this house than in either of the other two houses for storage. This is probably due to the difference in the construction of the two houses, difference in geographical location, and probably the ventilators were operated more carefully in the cinder block house. The 2500 bu of potatoes required only 3110 kwh of current for both curing and storage from November 18, 1932, to April 1, 1933, or approximately 1.25 kwh per bushel. No other method of heating was used, except one day when a stove was installed to help keep the room temperature up while the potatoes were being removed from the house for shipping. The weather was unusually cold, and because of the fact that the doors had to be opened a great deal of the time while removing the potatoes, the stove was used temporarily for auxiliary heat that one day.

The results obtained with this house were very satisfactory, although about 50 bu, or 2 per cent of the potatoes, were lost due to overheating immediately over the heaters. This was the same trouble experienced in the experimental house the year before, although not as serious. The remainder of the potatoes were cured perfectly and the current consumption was low enough to make the process very economical.

House No. 3. This house was the same design and capacity as House No. 2, except that it was of wood construction instead of cinder blocks. It was located on the Virginia State Farm near Richmond, and about 125 miles north of the cinder block house described as House No. 2. The capacity of the house was 2000 bu in crates, but only 1600 bu were grown and stored last season. The arrangement of the heaters and ventilators was the same as in House No. 2, except that the ventilated partitions forming the bins were not built in this house. Sixteen 500-watt strip heaters were operated on four circuits of four heaters each, and were controlled by a thermostat. The heaters were connected in parallel and operated on 115 volts. There was an air space of 12 in between the floor and the false floor.

The curing period for this house was 14 days, and a wood stove was used for heating the house the first 9 days due to the late arrival of electrical equipment. Both stove and heaters were used for the remainder of the curing period, and electric heaters alone were used for the entire storage period of seven months. The electric consumption for the curing period was 1152 kwh, and 7405 kwh were consumed during the storage period. A total of 8557 kwh were used for the curing and storage of 1600 bu of potatoes for seven months, or about 5.3 kwh per bushel.

No potatoes were lost in this house due to faulty curing or storage. About 0.5 per cent were lost all over the house, this loss being caused by a rot resulting from bruises in handling the potatoes. The officials at the state farm were well pleased with the operation of the house and are planning to operate it this season just as they did in 1932.

The following data gives a summary of the details of the three houses for comparison:

House	Bushels stored	Construction	Connected load, kw	Curing period	Storage period
No. 1	700	Wood	5.2	10 days	6 mo
No. 2	2500	Cinder block	8.0	16 days	4½ mo
No. 3	1600	Wood	8.0	14 days	7 mo

House	Total kwh used	Stove used	Losses, per cent
No. 1	1108	10 days (curing)	0
No. 2	3110	1 day (shipping)	1.8
No. 3	8577	14 days (curing)	0

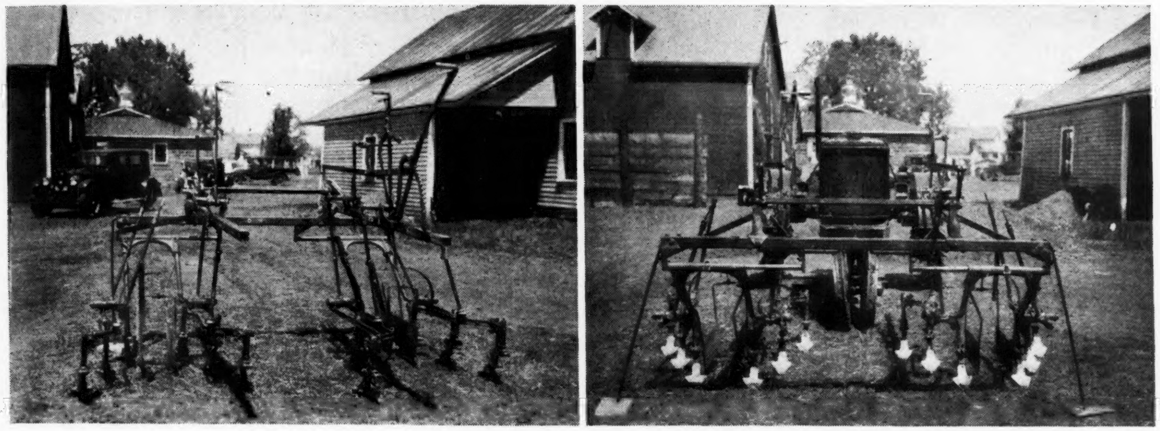
The results obtained in each of the electrically heated sweet potato houses were very satisfactory to the owners of the house. The tin baffle used in the 700-bu house proved unusually satisfactory although it appears that a 12-in air space under the potatoes will prevent overheating as shown by the results in House No. 3. The winter of 1932-33 was an average severe one for tidewater Virginia, and therefore the current consumption can be assumed as an average for any year in this section. The amount of current required is dependent on many factors other than the outside temperature, including the construction of the house and the operation of the ventilators.

In a locality where the winters are more severe, it appears that an arrangement using a stove located outside the potato house proper, in conjunction with the electric heat, would be good. An electric blower would force the hot air from the stove through the floor ventilators. The space usually occupied by the stove would then be made available for potato storage. The stove could be used with the heaters in curing and during prolonged cold periods, and the automatically controlled electric heaters would always keep the house above 50 deg F, during sudden cold snaps.

The information already obtained from experience with electric heat in sweet potato curing houses indicates that there will be no reason for farmers losing potatoes from chilling or overheating in the future, if they have electricity available.

The Engineer in Public Affairs

IF THE engineer is to be an important figure in public affairs, he must acquire a broader technique than that which he ordinarily possesses, and he must inform himself concerning a wide range of subjects of which ordinarily he knows little. Furthermore, he must acquire a wide knowledge of economic history and be able to trace the effect of economic changes over long periods of time. The broad economic problems that now trouble us are not isolated and circumscribed in character; most of them have long histories and many ramifications. . . . . Perhaps no field of knowledge presents such a bewildering array of theories which purport to tie together groups of phenomena more or less vaguely connected. He is indeed a bold man who will speak dogmatically about problems in political economy who has not studied this so-called "dismal science" long and carefully as a preparation. If the engineer can apply his analytical methods to these vague relations and develop the basic facts through his more intimate knowledge of industry, he can indeed become a most useful factor in public life.—Dexter S. Kimball in "Mechanical Engineering" for August 1933, page 473.



(Left) A cultivator unit, complete in itself, which can be attached to the tractor for which it was designed in a few minutes. (Right) This shows the tractor partly driv en into place in the cultivator unit

Present Day Tractor Well Engineered[1]

By Louis Jacobi[2]

MEETINGS of this kind are not for the purpose of spending time in contemplation of things already accomplished, but for an exchange of views which may result in the progress of the work in which we are engaged and ultimately work out for the benefit of all concerned. This makes it imperative to avoid generalities and concentrate on certain basic points. However small they may appear to be, they are vital nevertheless, when viewed in their position to the whole structure.

Let us examine the tractor proper as it is offered today. What do we find? A rather good machine in general; far better materials suited to specific requirements and much superior workmanship go into a tractor than did only a few years ago. If we examine a modern tractor transmission, for instance, we find cut gears of the best material that the trade has to offer, shafts and axles of alloy steel, ball and roller bearings throughout. Those parts, pointed out with pride only a few years ago, are commonplace today. Considering such points alone, the engineer might view complacently the work of his labor and studies; he might even be inclined to harbor modest pride. But if we look from far and visualize what the term "general-purpose tractor" implies, then we must admit that we fall short of the goal.

The engineer has produced a machine that proved and will prove again its economic advantage over animal power, a machine that has lifted immense burdens of labor from the farmer's shoulder, but it is a machine that is not as yet flexible enough for general utility. There are still too many reasons offered by the user why horses must be kept, in addition to owning a tractor. We do not know now whether an ultimate combination of horse and tractor will be the best solution, but we do know that the tractor in the function of replacing draft animals must be such that it can be hitched to the implement just as readily and just as quickly as can the horse. In this respect the engineer has not done all that is possible, and as long as we do not fulfill this condition we handicap the general use of the tractor. Too much time is often consumed in changing over from one implement to another. At no time should the usefulness of the tractor be impaired by first having to disassemble a number of parts in order to use the tractor.

Let me recall to you the meeting of the Power and Machinery Division of this society four years ago (Chicago, December 4 and 5, 1928), at which time a paper setting forth the requirements of the general-purpose farm tractor was presented. The requirements were clearly recognized then, and they are the same today. Among other points it mentioned: "A tractor must cultivate as well as plow without necessitating a shift in parts. The cultivator should be made so that the tractor can be driven into it and coupled in five minutes." This corresponded with the conceptions we had and brings me to the point I wish to stress, namely, the ease of adapting implements to the tractor, keeping always in mind that it should take only a few minutes to attach any implement. We have for ourselves solved the problem in that we have built the cultivator as a unit complete in itself. No part has to be added, none to be taken away after its use, and nothing can be lost or misplaced while it is not in use as the implement is always complete. No one will deny that such a feature is an advantage no matter to what it is applied.

This cultivator unit is shown in the left-hand view of the accompanying picture. It is built up of a cross beam and two side beams of square tubing on which are mounted the cultivating gangs, the depth regulating levers, and a lifting lever, by means of which all gangs are lifted.

The unit is supported by four rods, two in the rear and two in the front. After the cultivator is attached the rear supports are folded up and are held by a catch; the front ones are pushed inside the cross beam. The gangs, or particularly the arch, is readily pushed to the side on the supporting cross-bar to make room for the front wheels to pass. It is only necessary to loosen and tighten one setscrew to accomplish this.

After the tractor has been driven into the cultivator, two brackets, fastened to the front supports, will receive the cross beam of the cultivator. The brackets are made of flat bar stock, the ends curved downwards and upwards to facilitate guiding the tractor into posi-

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers held at Chicago, November 1932.

[2]Engineer, Allis-Chalmer Manufacturing Co. Mem. A.S.A.E.

tion. Two brackets, mounted permanently to the rear axle housing of the tractor, will receive the end of the side beams.

The right half of the accompanying picture is a front view showing the tractor partly driven into place. The gangs are pushed to the side, and there is sufficient clearance all around to move the tractor into place. In the rear are the two brackets which receive the side beams. After the tractor is driven into place, a pin with a loop fastened by means of a short chain to the bracket, to prevent losing it, is inserted through the bracket and beam and holds the cultivator in place.

In operation, the front brackets do the pushing of the cultivator and hold it in position vertically; the rear brackets hold it in place against forward, sideward, or upward movement. The brackets supporting the cross shaft for the gangs are spaced so as to form a stop against the motor front support to prevent sideward movement. The cultivator is held rigidly in position; only two pins are inserted by hand to hold it in place; only two setscrews have to be tightened. The unit is then ready for use, and it takes only five minutes to do it. This was made possible only with the cultivator built as a complete unit.

This cultivator is also provided with a power-lift device, which is an adaptation of a plow lift and receives its power through a worm gear drive by means of the regular power take-off shaft. The power lift is available for either the right or left side of the tractor. In case no power lift is used, the lifting rod on the power-lift crank is simply attached to the hand-lift lever which is a part of the cultivator. The power lift should always be used, as it is a muscle saver.

The development of the best universal tractor is still one of the weightiest problems concerning agricultural engineering. By "best" I include not only performance, but simplicity of design, with a consequent low cost of manufacture. I cannot conceive of a machine built in such a way that it is adjustable in all directions to accommodate a number of conditions, only to result in a higher cost of manufacture. Although the development of the tractor in many ways is analogous to that of the automobile, in quantity manufactured it will not measure up to the automobile, and, in consequence, with the low cost per unit. It is compulsory for the engineer to avoid all complication of design, even, I believe, sacrificing such points that might be termed desirable but not absolutely necessary, allowing, however, good performance, which of course is essential. The pneumatic rubber tire for tractor wheels will no doubt show its influence in greater comfort, all-around usefulness, and increased economy. Time moves on; the engineer either goes with it, or is pushed along. In the end a superior machine results.

The tractor has been sold in the past by stressing its economic advantage. The merit of its dividend-earning capacity is a prerequisite. The present time, with destruction in its wake, leaves not much of a gage on which to base comparisons pro and con. However, I believe the horse will not regain its place on the farm, but the tractor will continue its temporarily checked triumphal march. This will be due in no small measure to the fact that by its use the heavy burden of labor is lifted, setting free the time to pursue worthwhile things in life that cannot be measured in dollars and cents, but are so necessary to a happy existence.

The farmer will cling to the tractor just as the wage earner who lost his job tries to hold on to his car which accorded him so much pleasure. The world will right itself again, and in the meantime, there is much work to be done. The engineer concerned with the various phases of agriculture must forge ahead undismayed, trying to do his part to help agriculture back to a sound footing which it must have for fundamental reasons.

The Relationship Between Engineering and Home Economics

(Continued from page 301)

of equipment for the home and have shown in some detail the similarity in method used by the industrial efficiency engineer and home efficiency expert. It seems to me that the agricultural engineer stands in much the same position with respect to the farmer that the home economist does with respect to the woman in the home. The agricultural engineer is trying to make work conditions and equipment better for the farmer in order that the farmer may increase income, lessen physical fatigue, and in the end have a richer, happier, more satisfactory life. He must interpret the farmer's needs to the manufacturer and see that the farmer knows and has the means to make use of what the manufacturer has to offer.

The home economist is in a very similar position with respect to the housewife and the manufacturer. The home economist is trying to make life easier and pleasanter for the woman in the home. In her various positions in manufacturers' organizations, the home economist is interpreting the woman's needs to the manufacturer, and she is bringing the manufacturers' products to the homemaker with intelligent suggestions for using these in individual situations.

The agricultural engineer comes closer to the home than any other engineer does, because the farm and home are more closely tied up than are the home and other types of business. Supplying power and water for the farm buildings usually means also supplying these same facilities for the farmer's home. The use which can economically be made of electricity in the home may affect the cost of current for farm operation, and vice versa. Use of modern equipment in the farm kitchen may cut out the cost of hired help, and so the farmer's income is affected. Living on the farm and earning a livelihood on that farm are so closely related that what affects one is bound to affect the other in a far greater degree than is true of any other way of living or earning a livelihood.

This close relationship between the farm and the farm home has been well brought out in the work done by the Committee on the Relation of Electricity to Agriculture. In that work the relation of electricity to the home necessarily received attention. The home economist and the agricultural engineer worked together on this project with the electrical, the mechanical, the chemical, and other engineers. The everyday problems of farm and farm home are just as closely tied up as were the problems attacked in these experiments. The agricultural engineer has been one of the first of the group of engineers to be interested in the problems of the home. It is quite fitting that he should lead the way to a closer relationship between the engineering profession as a whole and the home. He understands better than any other engineer can possibly understand the problems of both, and he can speak the language of either.

He and the home economist should accomplish much for the home whether it be in country, town, or city, for the essential provisions for housekeeping are becoming more and more alike wherever they are located. Together they can reduce the mechanics of living and making a living to a minimum. The farmer and the housewife will then have time and energy for intellectual pursuits and creative activity. They will have a rich and happy life which could never be theirs without the engineer.

The Disposition of Drainage Water from Milking Barns[1]

By H. B. Walker[2] and H. L. Belton[3]

THE six counties included in the metropolitan districts of California have a total population of approximately 3,800,000 people to which are distributed daily about 250,000 gal of fresh milk[4]. These counties comprise five districts, generally referred to as the Los Angeles, the San Francisco Bay, San Diego, Sacramento, and Fresno areas. The first two include the largest population centers. For the most part, the milk sheds serving these areas are near at hand with a majority of the producing dairies situated in thickly populated regions.

The sanitary requirements for market milk production necessitate the use of considerable volumes of water for the washing and cleaning of cows and barns, hence the subsequent disposition of the wastes has become a problem of increasing importance, particularly in unsewered areas where natural drainage conditions are not favorable. The methods of disposal described in this paper have been formulated after preliminary field and laboratory investigations made by the authors in cooperation with the dairy inspection division of the department of health of Los Angeles County.

In 1930 the Los Angeles Health Department[4] had approved 1400 dairies as sources of fresh milk. These dairies contained about 80,000 cattle of which nearly all were dairy cows. Dairies listed as sources of bulk milk for pasteurizing contained about 60,000 head, or 75 per cent of the total. The dairies within Los Angeles County included nearly 70 per cent of the cattle in all approved dairies. This county alone had a total of 978 approved herds containing 55,290 cattle. The 1930 population of Los Angeles County was 2,208,492.

The dairy cattle in this area are kept in dry lots and roughage is fed in bunks as cured or green hay, root crops, silage or other available forage crops. Milking is done in milking barns where normally concentrates and sometimes silage are fed. Milking barn capacities range from 33 1/3 to 100 per cent of the herd size with the tendency in practice distinctly toward the smaller barns. The cows remain in the barn from one hour and twenty minutes to three hours. About two hours is the average.

Sanitary regulations require that the cows shall be washed at each milking and that the standing platforms, gutters, litter alleys, and back walls shall be cleaned and washed after each string of cows is milked. Mangers and feed alleys are washed normally not oftener than once each day.

Studies were made of selected dairies in the Los Angeles and Sacramento districts to determine the quantity of water used in washing cows and barn cleaning. As one might expect, this was found to be quite variable depending upon the thoroughness of cleaning, methods of management, nature of water supply, and weather conditions. Under thorough inspection service, however, the first factor is fairly well handled. As a rule, in California the rear quarters of the cow are clipped and the cows are washed with water direct from a hose. In some cases dry cleaning is practiced as a preliminary to washing. The latter method requires much less water. The removal of solids from gutters should be done preferably with shovels, but when hired milkers are employed, water is often used for flushing out all solids. Broom and shovel work when intelligently done materially reduces water requirements. Our records indicate that water pressures are a factor with high pressures contributing to increased consumption. Weather conditions influence water consumption. Although the rainy season comes during the winter months, only slight freezing ever occurs so that little if any animal shelter is required. During the winter months when corrals are muddy, cow washing requires more water, particularly when the mud is stiff, as during the first few days of drying weather following a storm. Meter records from typical dairies showed that water demands for cleaning cows and floors varied from 5 to 25 gal of water per cow per milking, although most dairies ranged from 8 to 14 gal. A little more water is used normally for washing the barn than for washing the cow. Analysis of our field data led to the adoption of 11 gal per cow per milking as a normal use for good sanitation under California conditions.

Rate of use of water is an important factor in designing disposal systems. While pressures available affect the rate of consumption, the number of workers and hose connections more nearly determine the rate of use. Individual workers use water at variable rates since hose outlets are regulated to suit the work of washing animals or flushing floors and gutters. The maximum rate with one man working with a single hose rarely exceeded 10 gpm (gallons per minute), so this was adopted as a maximum for a single worker. With two workers the maximum rate was found to be less, averaging about 18 gpm. In most cases not more than two men used water at a time, but when more did work, the rate of use per worker diminished with the increase in number of workers due primarily to lower delivery pressures and diversity in demand.

The quality or composition of dairy barn waste water varies with the season and type of barn management. In order to get a reasonably good picture of the character of the water coming from dairies in the Los Angeles district chemical analyses were made of samples of the effluent water from selected dairies. As might be expected, wide variations resulted due to the factors already mentioned and to difficulties from sampling. Total solids varied roughly from 4,000 to 40,000 ppm (parts per million), with organic solids ranging from 3,000 to 33,000 ppm and fixed solids (inorganic) ranging from 1,200 to 28,000 ppm. For California conditions it was decided that approximately 15,000 ppm would be representative. Due to the fact that our field samples were taken in the summer, no doubt a lower percentage of inorganic matter was found than would occur during the rainy season. The solids present in the field samples showed approximately 60 per cent organic and 40 per cent inorganic. The organic material is principally feces and urine with some waste feed from the mangers. The inorganic materials are mostly clay, silt, sand, and some gravel. The color of the waste liquid is dark green with the organic and inorganic materials mostly in suspension. The volume

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[1]Paper presented at a session of the Structures Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, Lafayette, Indiana, June 1933.

[2]Agricultural engineer, California Agricultural Experiment Station. Mem. A.S.A.E.

[3]Farm building technician, California Agricultural Experiment Station. Mem. A.S.A.E.

[4]Leland Spencer. "An Economic Survey of the Los Angeles Milk Market." Bulletin 513. California Agricultural Experiment Station, May 1931.

of organic materials is relatively large due to the bulk of the light fibrous materials contained in cow dung. All of the materials are quite readily transported by water and the quantity used induces sufficient velocity of flow in gutters having slopes of 1 in in 10 ft to carry these wastes away.

In the Los Angeles area a dairy farm is really a raw milk production plant. The land areas available are relatively small. Sometimes the animal density will be as high as 50 cows per acre and densities of one-third this number are not unusual. When one considers that the quantity of water used for cleaning and washing is normally about 22 gal per cow per day, the disposal of these wastes becomes quite a problem if nuisances are avoided. Certain areas are now equipped with sanitary sewer systems, and this must become more general in the future or animals eventually must be moved out. Even with sewer facilities, the fly and odor problems are troublesome. Ordinarily there is a splendid market for the manurial by-products to orchardists, truck farmers, and home owners.

Where sewer facilities are not available, it is necessary to convey the waste water to sumps, cesspools, or tank containers where it may be leached away through tank floors and walls, or later pumped over land surfaces for disposition by broad irrigation. The leaching of these liquid wastes is very difficult since the colloidal substances present of both organic and inorganic types contribute to very slow filtration through the fine-textured soils and these readily clog coarser soils when kept constantly wet. A common practice among California dairymen has been to discharge wastes into tanks which serve more or less as settling chambers to separate the solids from the liquids and then discharge the overflow liquids into open ditches for ground seepage. These tanks require frequent cleaning of solids, if nuisances are to be avoided, and the overflow liquids almost invariably become nuisances because of the troubles encountered in soil absorption.

The drainage difficulties have been further aggravated by the rapid increase in size of dairies. The average number of cows per dairy in 1927 was 28.7, while in 1930 the average per dairy was 50.5, or an increase of 76 per cent[4]. In many instances the increase in animals per dairy has taken place without proportionate increase in land areas so that the drainage problems have become increasingly more troublesome in dairy sanitation.

With these preliminary data as a background, the authors conducted a series of experiments at University Farm at Davis to secure data on which to design suitable tanks to separate the solid and liquid wastes so that final disposal might be accomplished with less likelihood of creating nuisances. In these tests an effluent of 11 gal per cow per milking was used having 15,000 ppm of waste made up of approximately 0.9 lb of dry earth and sand and 2.7 lb of 80 per cent moisture cow dung to each 11 gal of water. Tests were run with effluent rates of 10 and 18 gpm and for volumes equivalent to 20 and 50-cow herds. Sedimentation methods were tried first.

The first sedimentation test tank was designed for 50 cows with a 12-h detention period and a maximum lineal velocity of flow of 20 ft per hour (about 1.67 mm per second). The tank was approximately 3 ft wide, 30 in deep below the effluent end, and 10 ft long. The rate of sewage flow used was 18 gpm. Inlet baffles and outlet scum boards were provided. (See Fig. 1a.) The performance of this tank was quite satisfactory in that it settled out approximately 88 per cent of the introduced solids. Of those passing out with the effluent about two-fifths were filterable and three-fifths were in the filtrate. These effluent solids were approximately 50 per cent organic and 50 per cent inorganic, thus producing a relatively stable effluent, but the colloidal materials in suspension prevented ready soil absorption. The settleable solids due to the bulk of the organic solids quickly reduced the effective tank volume so that continued use without frequent cleanings increased the volume of solids carried over. The removal of the tank solids was not easily accomplished since practical operating conditions do not permit the removal of the tank liquors by gravity without great loss of head, and to remove the solids while the tank is full is both difficult and unsatisfactory. The hydraulic value of the fine silt and clay particles carried over into the effluent is such that it is hardly practical to maintain a detention period long enough to produce complete sedimentation. The most important materials to remove, however, are the bulky organic fibers since it is these which contribute to nuisance conditions both in settling tanks and in the tank effluents.

In order to overcome some of the operating disadvantages of the plain settling tank, it was next decided to take advantage of the suspended fibers to form built-up filters on stationary screens placed in shallow tanks designed for continuous gravity drainage so as to permit the removal of the drained solids by shovels or other "dry" methods. For these tests a shallow tank 9 in deep, 3 ft wide, and arranged for variable lengths from 6 to 10 ft, was used. (See Fig. 1b.) The longitudinal floor slope was approximately 1½ in in 10 ft. Screens ranging in coarseness from ½ to 1/16-in mesh were used in combination. The same makeup of barn sewage was used as for the earlier tests, but the total volume was limited to 220 gal per run, or for an equivalent herd of 20 cows. Floor baffles 4 in high were placed between screen settings, and these screen settings were varied in placement in the tank. It was found by experiment that most satisfactory operation was secured when ½, ¼, and ⅛-in screens were used in combination, the coarsest being placed near the influent end, the intermediate size a little past center toward the effluent end, and the ⅛-in size at the effluent end. Screens finer than ⅛ in were unsatisfactory. Scum boards were used but these were of questionable value. Fig. 1 shows the general arrangement of screens and baffles which gave the most consistent results. In these runs we were able to recover from the screen chamber from 70 to 80 per cent of the introduced solids, and from 86 to 96 per cent of the introduced materials could be accounted for by our analysis of all recoverable products. The effluent was somewhat darker than when a plain settling chamber was used since the linear velocities were three to four times higher (about 5.5 mm per second) which was sufficient to transport most of the fine clay and silt. Naturally a part of this by-passed the screens, since the velocity of the sewage was depended upon to impinge the fibrous organic matter on the screen surface to build up a temporary filter to intercept the solids and colloidal substances. The filterable solids in the filtrate

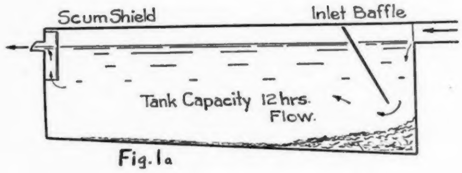


Fig. 1a

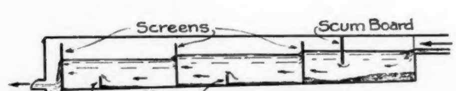


Fig. 1b

These drawings show the general arrangement of the plain settling tank (Fig. 1a) and the screen chamber tank (Fig. 1b) used in the California dairy drainage experiments

averaged about 1100 ppm, and the solids in the filtrate were approximately the same. These, however, represent but little volume and are not particularly objectionable during subsequent disposal.

These experiments indicated that it was possible to make effective use of screen chambers to separate solids from the liquid wastes from dairy barns and that shallow, easily cleaned chambers were practicable. Usually it required about one hour for the screen chamber to drain after barn cleaning. The screens which were made of hardware cloth supported by suitable frames, were held in place by wall slots. After drainage these were withdrawn, and when struck flatly on the side of the tank with the up-stream face downward, the impinged fibrous covering fell to the tank floor and the screen was left clean. Floor baffles were likewise made removable so that the shallow tank floor could be quickly cleaned with a shovel just like a regular barn gutter. The solids were shoveled into a wheelbarrow or other container and placed in storage with other solids as manure.

The design of the screen chambers must be more or less empirical, but the following variables should be considered:

1 Total number of cows. This depends upon size of dairy and methods of handling cows in the milking barn.

2 Quantity of water to be handled. In California approximately 11 gal of water per cow per milking is used for cleaning cows and barn.

3 Maximum rate of concentration of barn sewage. This was determined to be 10 to 18 gpm for most dairies.

4 Depth of screen chamber. For normal conditions depth should be relatively shallow to avoid loss of head in the drainage system; 9-in to 12-in depths are most desirable.

5 Cross section of chamber. When the maximum rate of flow is known, the cross section should be fixed to produce desirable linear velocities for the separation of solids from the liquids. Cross sectional areas of approximately 20 sq in per gallon per minute of maximum rate of use gave satisfactory results for California conditions. This produces a linear velocity of approximately 5 to 6 mm per second which tends to remove sand by sedimentation to the tank floor and to collect fine silt and clay particles with the fiber on the screen surfaces.

6 Length of chamber. A certain tank volume is necessary and this depends upon the number of animals served. A total effective volume of approximately one-half the total volume of barn sewage handled per milking appears to be satisfactory. This is secured for California conditions when the length (l) in inches equals six times the number of stanchions in the barn.

7 Kind, size, and placing of screens. Three sizes of screens (½, ¼, and ⅛ in) have been found satisfactory in preliminary tests. These should extend the full width of the tank and should be about one-third deeper than the tank depth at the influent end. Longitudinal placing and size of mesh will vary with operating conditions. The coarsest should normally be placed about one-third the length from the influent end and the finest near the tank outlet. A final sediment trough beyond the last screen may be used.

8 Method of barn cleaning. The operation of the screen chamber assumes that some wet dung will be flushed through the gutters. If screens are properly selected and placed, the method of cleaning and washing cows is not of great importance so far as tank operation is concerned.

Following is an example of the design of settling chambers:

Let l = length of chamber in inches
w = width in inches
d = depth in inches
r = rate of flow in gallons per minute
c = constant depending upon rate of flow = 20 for California conditions.
n = number of stanchions.

Then $w = \dfrac{20\,r}{d}$

For most cases d should be (preferably) about 10 in, in which case

$w = 2r$
and $l = 6n$

The final sediment trough if used should be about 4 in deep and of standard gutter width. Fig. 2 shows a design for a 40-cow dairy.

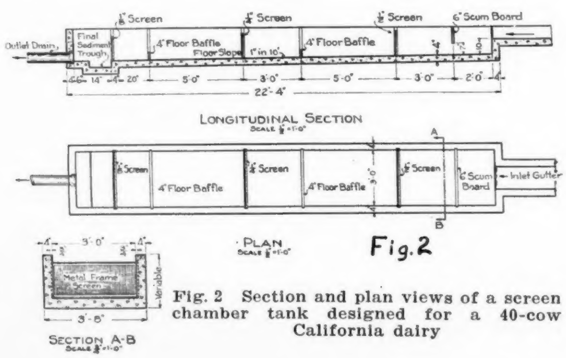


Fig. 2 Section and plan views of a screen chamber tank designed for a 40-cow California dairy

The tank effluent is dark green in color and free from coarse materials. The outlet may be an open or covered drain as desired. About 50 per cent of the solids passing the tank are filterable and of these solids roughly 50 per cent are organic. The colloidal substances present of both organic and inorganic types contribute to slow filtration through soils when kept continuously wet. For this reason and also due to the volume of water, the usual subirrigation methods for final disposal are not applicable. The effluent is in splendid condition for disposal through sanitary sewer systems, but where such service is not available local disposal must be obtained. The most logical disposal of the effluent is by broad irrigation. Tank effluents may be collected in tanks or sumps, and at intervals of three to five days spread over the soil. Effluents from sewage of the composition used in our experiments contained about 45 ppm of nitrogen. This is equivalent to approximately 40 per cent of the total nitrogen contained in the wet dung mixed with the sewage water. It is apparent such effluents are valuable for both irrigation and fertilization. These are favorable factors for California conditions where our temperatures will permit surface applications of water throughout the year. It is important, however, to rotate the irrigated areas so that alternate drying and wetting are secured, and preferably with some type of surface cultivation between applications. Under normal California conditions of dairy management for grade A raw milk production, one cow will produce 0.024 acre-feet of barn sewage per year.

Chemical methods of precipitation were tried out to clarify the effluent from screen chambers. Ferric sulphate [$Fe_2(SO_4)_3 . X H_2O$] was used in our experiments. This quickly produced a relatively clear liquid which was readily absorbed by the soil. In districts where land areas are very restricted for absorption of effluents, chemical treatment of effluents might be justified.

Field studies are in progress to determine the practicability of shallow screen chambers for the treatment of dairy barn sewage in the metropolitan districts of California. Sufficient data have not been secured to date to warrant recommendations for general use, but present experience is encouraging.

The Economic Design of Wells and Pumping Plants[1]

By M. R. Lewis[2]

THE use of wells for the drainage of irrigated lands is expanding. In most cases the water obtained in this way is used to supplement irrigation supplies, and in some cases systems of wells originally installed for drainage purposes have later been operated primarily for irrigation. The problems of the design of wells and equipment for the two purposes are in most respects identical.

At least six of the western state agricultural experiment stations are carrying on some work on the development of ground water. This is an indication of the importance of this field. In Oregon it has been necessary to attempt to determine the proper size of wells and pumps for four demonstration and experimental units, and for a number of individual farmers. Little seems to have been published on the many problems that arise.

It is realized that conditions in the field could not be reduced to mathematical formulas, even if they could be accurately foretold in advance of the actual drilling and testing of wells. However, much useful information can be secured by a study of the theory of the flow of ground water. This paper is chiefly an attempt to point out the ways in which theoretical studies may help in the actual design of pumping systems for drainage or irrigation and to present certain typical results.

Drainage Wells. In the use of wells for drainage it seems natural to expect that their location should be chosen by a consideration of the shape of the draw-down curve or cone of depression. This method of locating wells is analogous to that of placing tile drains or open ditches in the wet spots or, in the case of large plane areas, at fixed distances apart, the location and spacing being fixed by the distance to which it is expected that the water table will be lowered to a safe depth.

With that idea in mind some study has been given to the shape of the draw-down curve. This study[3] showed quite conclusively that drainage by means of wells can be accomplished within reasonable cost limits only by a general lowering of the water table. Exceptions to this rule are those cases where the area to be drained is less than a few hundred feet in diameter. Somewhat similar conclusions had been reached by many drainage engineers working with large open ditches. The problem seems to be to develop the water with little regard as to where or how it is done.

Since this is true, the problem of pumping from wells for drainage is reduced to almost the same factors as that of pumping for irrigation. In both cases water must be produced at the lowest possible cost per acre-foot.

Factors Affecting Cost of Water. This cost of production will be affected by many factors, which may be classified as follows:

1. Geological factors: (a) Depth to the water table or piezometric surface, (b) thickness of the water-yielding strata, (d) depth of the water-yielding strata, (c) character of the overlying strata, and (f) conditions under which water is held, that is, artesian vs. water table, and conduit vs. reservoir.
2. Design of well or wells: (a) Depth, (b) diameter, (c) spacing of wells, and (d) strainers.
3. Design of pumping plant: (a) Type of pump, (b) character of power, (c) efficiency of pump, and (d) size and capacity of pump.
4. Operating conditions: (a) Cost of power, (b) continuity of operation, (c) cost of attendance, and (d) quantity of water pumped per season.

In addition to these factors affecting the cost of delivering water at the surface of the ground at the well, a number of other items, such as the effect of the size of the stream on the efficiency of application of irrigation water and the effect of the number and spacing of wells on the cost of ditch construction and maintenance, must be considered in practice.

All of these factors are interrelated and nearly all of them are present in each installation. Obviously it would be impossible to devise a formula by which all the factors could be evaluated and the most economical plant designed. Evidently the problem must be divided up and the different phases attacked separately. In doing this it seems worth while to determine mathematically the effect of changes in individual factors while other factors are held constant. It is, of course, impracticable to take up all possible interrelations in the course of a single paper. Methods of solution will be indicated in a few cases with illustrative results. Other problems might be attacked in a similar way.

Effect of Diameter of Well. Gardner, Israelsen, and McLaughlin[4] in an analysis based on conditions in the Cache Valley, Utah, studied the relation of the diameter of well and depth of draw-down to the cost of producing water. They discussed "open bottom" wells, that is, wells drilled through an overlying, more or less impervious, stratum just into a water-yielding stratum. The results of the tentative computations indicate that wells several feet in diameter would be most economical under such conditions.

Studies of the capacity of wells drilled clear through the water-yielding stratum, as related to all cost factors, indicate that with this type much smaller wells will be most economical. The discharge of a well of this type is given by the formula

$$Q = \frac{2\pi D k h}{\log_e \frac{R}{R_1}} \qquad [1]$$

Where
Q = discharge of the well
D = thickness of the water-yielding stratum
k = transmission coefficient (that is, the quantity of water which would flow through a prism of the material of unit dimensions under a pressure difference at the two ends equivalent to unit head of water)

[1]Prepared under the direction of W. W. McLaughlin, chief, division of irrigation, Bureau of Agricultural Engineering, U. S. Department of Agriculture, and W. L. Powers, chief in soils, Oregon Agricultural Experiment Station. Presented at a meeting of the Western Irrigation and Drainage Research Association, at Tucson, Arizona, July 1931. Released by the author for first publication in AGRICULTURAL ENGINEERING.

[2]Irrigation engineer, Oregon Agricultural Experiment Station, and Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

[3]Lewis, M. R.; Flow of Ground-water as Applied to Drainage Wells, Trans. Am. Soc. Civil Eng's.; V. 96 p. 1194-1211; 1932.

[4]Gardner, Willard; Israelsen, O. W., and McLaughlin, W. W.; The Drainage of Land Overlying Artesian Basins; Soil Science, V. 26, p. 33; 1928.

h = the draw-down at the well
R_1 = radius of the well
R = radius of the zone of influence.

In this paper Slichter's usage in the matter of the transmission coefficient has been followed[5,6].

Under the assumptions made in developing the above formula[7], there can be no such thing as a limit to the zone of influence. If the data necessary for a determination of the contributing area are available, the formulas[8] for a well being fed from the overlying strata get away from the difficulty of an indefinite value of R. It is apt to be almost as hard to secure these data as it is to estimate a correct value for R directly, and the formulas are more cumbersome than the one given above. Moreover, both formulas give practically the same results for the portion of the curve near the well. If the value of R is reasonably large, the effects of changes in other factors can be studied with fair assurance that the results will be qualitatively correct.

For any individual location, the values of D, k, and D_t (the total depth of the well) will be constant. The zone of influence may be assumed to be constant. Now to find the most economical diameter of a well on the basis of the cost of drilling and casing, we may determine the cost per unit quantity of water with a constant value of h and varying values of R_1.

Drilling costs quoted by Schwalen[9] increase at much less than a direct ratio with the diameter and only slightly over that ratio with depth of wells. In fact, for all depths common in drainage work and in irrigation projects in many sections, the cost of drilling per foot of depth does not vary with depth. In this paper the cost of drilling and casing is assumed to be directly proportional to the diameter and to the depth, except that minimum dimensions of 6 in diameter and 50 ft depth are taken. Adding the costs of casing and of drilling as given by Schwalen gives a price of approximately 50c per foot depth per inch of diameter.

The total cost of the well may be expressed by the formula

$$P_t = P_w R_1 D_t \qquad [2]$$

and the cost per unit quantity of water by

$$z = \frac{P_t}{Q} = \frac{P_w R_1 D_t}{Q} \qquad [3]$$

Where
P_t = the total cost of drilling and casing the well
P_w = the price for drilling and casing per unit radius and per unit depth
z = the cost of drilling and casing the well per unit quantity of water.

Substituting the value of Q from Equation 1 we have

$$z = \frac{P_w D_t}{2\pi D k h} R_1 \log_e \frac{R}{R_1} \qquad [4]$$

[5]If the energy gradient causing flow is to be given in units of force per unit of mass (e.g., dynes per gram of water) instead of in terms of the hydraulic gradient (e.g., feet loss of head per foot of travel), the term **h** must be multiplied by **g** (gravitational force per unit mass), and the corresponding coefficient of conductivity used.

[6]Since this paper was presented Israelsen's paper, entitled "Coordination of Research Concerning the Flow of Water in Soils" has been published in AGRICULTURAL ENGINEERING, Vol 12, No 12 (December 1931). He discusses the various conductivity factors which have been proposed and suggests that the coefficient referred to in the preceding footnote be designated as the "specific water conductivity."

[7]Lewis, M. R.; Flow of Ground-Water as Applied to Drainage Wells; Trans. Am. Soc. Civil Eng's.; V. 96 p. 1197; 1932.

[8]Ibid, p. 1199, Formulas 5 and 10.

[9]Schwalen, Harold C. The Stovepipe or California Method of Well Drilling as Practiced in Arizona, Arizona Exp. Sta. Bul. 112, 1925.

Mathematical examination of this formula shows that the most economical well, on the basis of the cost of drilling and casing alone, is the smallest one feasible. According to these formulas, the limit is at zero diameter. Actually, other considerations, such as the size of pump, will control. If this were not so, the point would be reached where Darcy's law no longer held.

Since the ratio R/R_1 is always large in normal pumping operations, it is evident that relatively large changes in the value of R_1 will have little influence on the quantity of water delivered by the well. This may be a little clearer if the formula is written in the form

$$Q = \frac{2\pi D k h}{\log_e R - \log_e R_1} \qquad [5]$$

If $R = 2000$ ft, a change in the value of R_1 from 0.25 ft (for a 6-in well) to 1 ft (for a 24-in well) only changes the value of $\log_e R - \log_e R_1$ from 9.0 to 7.6. This means that, other things being constant, the capacity of a 6-in well will be 84 per cent of that of a 24-in well, so long as the critical velocity for Darcy's law is not reached and casing perforations are adequate. A table of the reciprocals of the quantity $\log_e R - \log_e R_1$ for various values of R from 500 to 50,000, and for wells from 4 to 18 in in diameter, is published in the Journal of the American Water Works Association for June, 1930.

A similar study of wells installed under water table conditions, and also of open bottom wells, reaches the same conclusion, that is, that so long as only cost of drilling and casing is considered, the smaller wells are the more economical. In the case of wells of the latter type, since the flow of water reaching the well is almost proportional to the diameter of the well, the cost per unit quantity of water is practically equal for all sizes of wells to which the price assumptions herein made will apply, say, from 6 to 24 in in diameter.

Effect of Cost of Pumps on Economical Diameter. The cost of deep-well turbine pumps of fixed length may be represented fairly well by the formula

$$P_p = M_p + N_p Q \qquad [6]$$

where P_p = the price of the pump, and M_p and N_p are constants.

Recently one of the pump manufacturers issued a circular giving list prices of deep-well turbine pumps. From this list the respective values of M_p and N_p for pumps set 60 ft in the well and delivering water at the ground surface are approximately \$600 and \$369, when Q is given in cubic feet per second. The discount to individual consumers was about 45 per cent from this list in the spring of 1931. The cost of pump house, if one is required, installation, electric accessories, etc., can be assumed to be covered by the discount available from the list price. If this is not a satisfactory approximation, other constants may be substituted.

The total cost of our well, equipped, is expressed by the formula

$$C_t = P_w D_t R_1 + M_p + N_p Q \qquad [7]$$

and the total cost per unit of water by

$$z_t = \frac{P_w D_t R_1 + M_p}{Q} + N_p \qquad [8]$$

Substituting the value of Q from Equation 1 we have

$$z_t = \frac{(P_w D_t R_1 + M_p) \log_e \dfrac{R}{R_1}}{2\pi D k h} + N_p \qquad [9]$$

The minimum value of z_t is found to be with a well

smaller than 6 in in diameter and 50 ft deep, even when the \$600 minimum price for a pump is included. Undoubtedly very similar results would be reached by a study of wells under water table conditions.

With open-bottom wells the effect of the minimum price for the pump is to make most economical the well with the largest diameter to which the assumptions made herein will apply. Evidently the assumption that the cost will increase directly as the diameter cannot hold indefinitely.

If it is assumed that the cost varies with the square of the diameter and that R_1 is very small as compared with R, the size of well giving the lowest cost per unit quantity of water can be computed as follows:

$$z_t = \frac{P_w D_t R_1^2 + M_p}{Q} + N_p \qquad [10]$$

$$Q = \frac{2\pi k h R R_1}{R - R_1} \qquad [11]$$

If R_1 is negligible as compared to R,

$$Q = 2\pi k h R_1 \qquad [12]$$

$$z_t = \frac{1}{2\pi k h}\left(P_w D_t R_1 + \frac{M_p}{R_1}\right) + N_p \qquad [13]$$

$$\frac{dz_t}{dR_1} = \frac{1}{2\pi k h}\left(P_w D_t - \frac{M_p}{R_1^2}\right)$$

Equating this to zero and solving for R_1,

$$R_1 = \left(\frac{M_p}{P_w D_t}\right)^{1/2} \qquad [14]$$

On the assumptions that the unit price used herein is correct for wells with a radius of 1 ft and that the depth is 100 ft, the minimum cost for water would be secured with a well of 0.707 ft radius.

Effect of Draw-Down on Cost of Water. Having fixed on the dimensions of the well, the size of pump to be installed must be investigated. In the main, this is a rather simple problem of balancing the fixed charges on more wells against the saving in power costs by reason of a lower draw-down. Where a single pump is being operated on any one of many commercial power schedules the power demand becomes a very important item.

These problems are illustrated by the well on the Harney Branch Experiment Station at Burns, Oregon. This well is used to irrigate an 80-acre demonstration unit devoted to small grains, peas, alfalfa, and potatoes. The season is short, and as a result 40 per cent of the seasonal irrigation supply is used during a single month. The gross duty of water is about 1.5 acre-feet per acre. The power schedule calls for a service charge of \$15 per horsepower per season plus 2c per kilowatt-hour for the first 250 kwh per horsepower of demand per month and 1½c for the balance.

The accompanying curves (Figs. 1, 2, and 3) show the method of determining the size of pump which would give the lowest cost per unit of water. Power costs are computed on the basis of using pumps which would load each of the commercial sizes of electric motors in succession. It is assumed that the pumps would be used for 24 h per day during the peak month. Capital costs are based on the actual cost of the well and estimated prices for pumps and motors.

It is interesting to note that, under the conditions obtaining at Burns, the lowest cost for water delivered at the ground surface at the well would be secured with a 7.5-hp motor and a pump with a capacity of about 1.3 second-feet at a total lift of 30 ft. As a matter

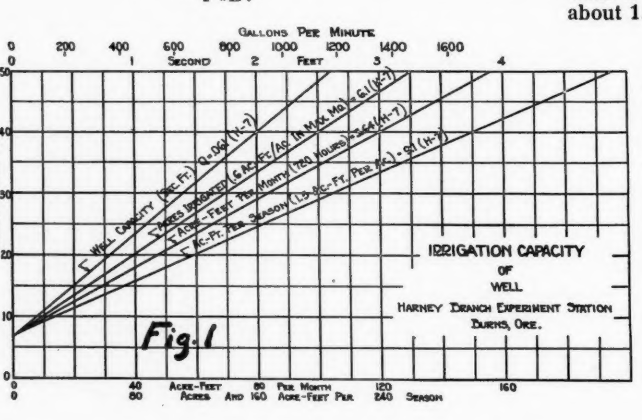
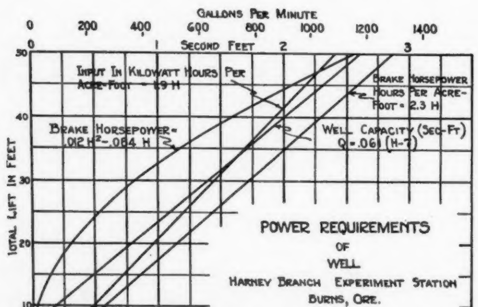
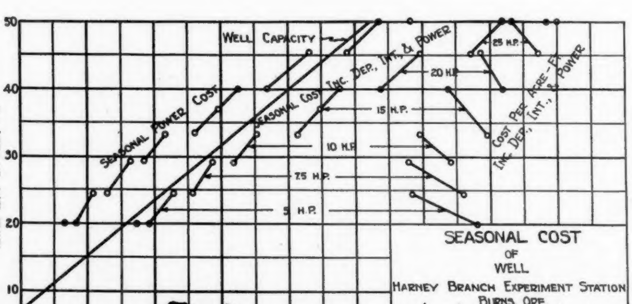


Fig. 1 Capacity of the well in gallons per minute or second-feet as shown by pumping test; capacity in acre-feet per month of continuous pumping; area irrigated to a depth of 0.6 ft in one month of continuous pumping; and volume of water pumped during the season to supply a depth of 1.5 ft on the area irrigable by continuous pumping during the peak month

Fig. 2 Capacity of the well from test (repeated from Fig. 9); brake horsepower at 58 per cent pump efficiency; brake horsepower-hours per acre-foot of water pumped; and kilowatt-hours input to motor, at 90 per cent motor efficiency, per acre-foot of water pumped

Fig. 3 Capacity of well from test (repeated from Fig. 1); cost of power for the season, including demand and energy charges; total cost per season, including power, interest, and depreciation; and total cost per acre-foot of water pumped. The sizes of motor required are shown





of fact, other considerations dictated the use of a pump with a 15-hp motor when this installation was recently electrified. The well had been operated with a 25-hp Diesel engine which was probably about right for that type of power.

Effect of Interference of Two or More Wells. Slichter[10] and Balch[11] have studied the effect of the interference of two or more wells. It is interesting to find the relative economy of two small wells as compared with one large well. Slichter gives the flow of two 6-in wells spaced at varying distances as compared with an isolated well under the same conditions. Under the conditions assumed, the combined flow of the two wells is 123.2, 130.9, 159.8, and 179 per cent of the quantity delivered by an isolated well when the two are spaced 5, 10, 100, and 400 ft apart, respectively. Under the same conditions, wells 10, 12, 18, and 24 in in diameter will produce 107, 110, 116, and 121 per cent of the quantity delivered by a 6-in well. With the cost assumptions used herein, two 6-in wells 100 ft deep, including equipment, would cost the same as one 24-in well of the same depth. If the 6-in wells were 5 ft apart they would produce a little more water, and if 100 ft apart, they would produce 32 per cent more water than the 24-in well.

Balch discussed the water works problem of the proper spacing of wells in a group, when more water must be obtained than can be secured from a single well. He pointed out that the economic distance between wells may be fixed by a study of the relation between the cost of connecting pipe and the value of the water developed. The limiting distance is that beyond which the increased cost of pipe is greater than the value of the increased capacity of the wells. Assuming that the cost of equipping the wells, the radius of the zone of influence, and the cost of pipe per unit of length remain constant, he found that the proper distance is that at which the connecting pipe costs 3/17 of the cost of a well completely equipped.

Safe Yield of Ground Water. Another type of problem merits profound study. That is the question of the safe yield of ground water. The question of fitting the irrigation development to the amount of ground water available for pumping is one of paramount importance which in many cases in the past has been studied only in retrospect.

Due, in part at least, to the fact that, ordinarily, deeper pumping from a single well will provide a larger quantity of water, there is a general belief that the same thing is true of a group of wells. Whenever a group of wells is so large and so distributed that it causes a general lowering of the water table in an area, increasing the depth of pumping will in no way increase the permanent total flow. Any individual well may still be made to produce more water, but it will do so only at the expense of the others. The great capacity for water storage of the strata under many irrigated areas has helped to obscure this fact.

In the typical far western valley, before pumping begins a state of approximate equilibrium has been reached between the accretions, to and the losses from, the ground water. Gains to ground water come from the percolation through the soil of the valley floor of rainfall and of excess irrigation water, from seepage losses from irrigation canals and natural streams, and from underground flow from higher areas.

Losses from the ground water occur as springs, effluent seepage in stream beds and swamp areas, evaporation where the capillary fringe comes to the surface, transpiration of plants whose roots reach the capillary fringe or water table, and underground flow to lower areas.

Pumping will reduce the losses by drying up springs and swamps and by lowering the water table and capillary fringe below the reach of plant roots. At the same time, the recharge to the area may be increased by making possible the percolation of water from rainfall and irrigation in the areas formerly saturated and, perhaps, by causing some canals and natural streams to lose rather than gain water by seepage. As soon as the maximum annual supply made possible by the reduction of losses and the increase of gains is secured, any further pumping will cause a cumulative lowering of the water table. The result will be that the pumping lift will keep on increasing and no permanent advantage will follow.

The point at which further development should stop is that at which losses have been prevented and gains have been secured to the greatest extent feasible. In most cases this will mean that the pumping lifts will be moderate as nothing will be gained by the higher lifts. This proposition seems so plain that it is strange more attention has not been paid to it.

Planned Development. Planned development of the ground water supply of a basin should, then, provide for lowering the water table enough to prevent losses and allow maximum gains every year. The wells and pumps should be designed to permit pumping to a sufficiently greater depth to provide storage space to care for a dry period of one or more years. It will be noted that this plan does not call for pumping to the economic limit of lift as ordinarily defined. Of course, if the economic limit of lift is less than the lift required under the plan outlined the former would control. However, the economic limit for a single year or for a part of a season when pumping from the stored supply would be needed probably would be greater than could be permitted for continuous operation.

[10]Slichter, C. S., Theoretical Investigation of the Motion of Ground Waters, 19th Ann. Rept. U.S.G.S. Pt. 2, 1899.

[11]Balch, Leland R., Hydraulics of Deep Wells, Journ. Am. Water Works Assoc., V. 22, p. 727, 1930.

New Trash Guide for Clean Plowing

A USEFUL and inexpensive trash guide or plow attachment to aid in complete plowing under of standing corn stalks and other debris has been invented by L. G. Schoenleber and A. H. Glaves, agricultural engineers of the U.S.D.A. Bureau of Agricultural Engineering, for use in plowing and particularly valuable for control of the European corn borer. A public patent on the device has just been granted, and doubtless manufacturers will soon have it on the market. The guides may be attached to either horse or tractor-drawn plows and to equipment of one or more plow bottoms.

Although the guides were designed primarily for plowing under cornstalks, they can be used for clean plowing of fields where other trash and weeds abound. Farmers have tested the guide equipment in plowing under cornstalks, hemp over 10 ft high, sweet clover tall enough to hide the tractor, and tall weeds, and in each case they were enthusiastic over its performance.

The guide is made of sheet metal usually about 1/16 in thick. This is bent to form a U-shaped loop, slightly conical, and acts as a funnel for guiding standing stalks into the furrow bottom in such a manner that the furrow slice as it is turned covers them completely. One trash guide is attached to each plow bottom.

The right-hand side of the front guide is pivoted to a collar on the outer end of the front axle. The right-hand side of the second and subsequent guides is pivoted to a bracket attached to the adjacent plow bottom brace. The left-hand sides of the guides are pivoted to brackets which are clamped to the colter shanks.

The tops of the guides are connected by chains or wires to a lever which raises the devices automatically when the plow for any reason is pulled out of the ground or is backed up. Lifting the guides protects them from damage.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

A NOTE ON THE MACHINES USED IN THE TESTING OF PADDY FOR BREAKAGE IN MILLING, *A. Hayes* (Agr. and Livestock in India 21 (1932), No. 2, pp. 162-169, pls. 2, figs. 8). Four machine are described and illustrated, including a seed mixer, a huller, a separator, and a rice pounder.

DETERIORATION OF DOMESTIC CHIMNEYS, I, II, *J. E. Maconachie* (Canad. Chem. and Metall., 16 (1932), Nos. 11, pp. 270-274, figs. 5; 12, pp. 292-295, figs. 4).—Studies conducted for two years at the Ontario Research Foundation are reported, in which special attention was given to the influence of flue gas condensation on chimney deterioration and the development of preventive measures.

A field survey of several cases of chimney deterioration and an analytical study of some of the products pointed to sulfuric and sulfurous acids arising from the condensation of some of the products of combustion as the chief causes of trouble.

Determinations of chimney temperatures and dew points indicated that, in order to prevent deterioration, turbulence in the flue gas stream should be avoided, and that an acid-resistant coating could be successful, and would, in contrast to metallic linings, entail little installation expense. A search for a suitable material resulted in the selection of an asphalt and chromate emulsion that proved to be particularly well adapted to the purpose.

An appendix lists materials tested for protective coating purposes.

AGRICULTURAL ENGINEERING AND SOIL EROSION INVESTIGATIONS AT THE WASHINGTON STATION, *L. J. Smith, H. L. Garver, C. A. Larson, W. A. Rockie, A. J. Johnson, and P. C. McGrew* (Washington Co. Sta. Bul. 275 (1932), pp. 9-11, 63, 64, 67-70, 73-75).—The progress results of investigations on heat movement in soils, apple-washing machinery, evaporation losses from sprinklers, water heating for dairy cows, electricity on dairy and poultry farms, grain-elevating machinery, orchard irrigation by overhead sprinklers, irrigation water measurement, specific conductance of soil and irrigation water, flue repair materials, vegetative control of erosion, terracing, operation of machinery on terraced land, tillage, strip cropping to prevent soil erosion, and wind erosion are briefly reported.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEW YORK CORNELL STATION, *F. L. Fairbanks, A. M. Goodman, J. C. Huttar, H. E. Botsford, and H. W. Riley* (New York Cornell Sta. Rpt. 1932, pp. 89, 90). The progress results of investigations of dairy stable ventilation, the ventilation of poultry houses for laying and breeding hens, milk-cooling equipment, and farm power machinery are briefly reported.

[AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE SOUTH DAKOTA STATION], *R. Patty* (South Dakota Sta. Rpt. 1932, pp. 4, 5). The progress results of investigations on corn harvesting machinery, use of the combine harvester-thresher, rammed earth for farm building walls, and the comparative length of service of galvanized steel posts and painted steel posts are briefly reported.

DRAINAGE OF LAND OVERLYING AN ARTESIAN GROUND-WATER RESERVOIR, *O. W. Israelsen* and *W. W. McLaughlin* (Utah Sta., Bul. 242, 1932, pp. 56, figs. 16.—This publication is based on data gathered under a cooperative agreement between the station and the U.S.D.A. Bureau of Agricultural Engineering. It reports investigations on the Cache Valley artesian basin area in Utah, during which a total of 773 static water-level measurements were made at more than 50 points throughout the area. Two large wells were used to facilitate pumping from the water-bearing gravels, and 25 flowing wells ranging from 2 to 5 in in diameter were also used.

Field measurements of the direction of flow of water in soils show that water flows upward through the compact soils overlying the artesian ground-water reservoir. The piezometric surface was appreciably lowered by the flowing of water from the artesian wells. Pumping caused a marked lowering of the piezometric surface at a distance of 1,500 ft from the pump, an appreciable lowering at a distance of 3,000 ft, and no lowering at a distance of 10,000 ft. It is physically feasible to pump water out of the gravel in large enough streams (and also large enough in total volume) to prevent the flow of water upward, and further to permit the flow of excess irrigation water and natural precipitation downward through the upper feet of soil as fast as the low permeability of the soil will let it flow. Measurement of discharge of water from tile drains in lands east of the artesian area did not show any relationship to the pumping of water from the artesian ground-water reservoir.

An appendix gives detailed data.

THE INFLUENCE OF SYSTEMS OF CROPPING AND METHODS OF CULTURE ON SURFACE RUN-OFF AND SOIL EROSION, *M. F. Miller* and *H. H. Krusekopf* (Missouri Sta. Res. Bul. 177 (1932), pp. 32, figs. 9).—An investigation covering a 14-year period is described the object of which was to determine the influence of different systems of cropping and cultural treatment on surface run-off and soil erosion. The soil on which the investigation was carried out was a rather poor quality of Shelby loam having an average grade of 3.68 per cent.

The plats, which were 1/80 acre in size, were 6 ft wide and 90.75 ft long extending lengthwise up and down the slope and ending in concrete catchment basins to receive the run-off water and eroded soil. There were originally seven of these with different cropping and cultural systems, but only six were carried without change for the 14-year period.

The average yearly precipitation for the 14-year period was 40.37 in as compared with a 44-year average of the local Weather Bureau of 37.80 in, or about 2.5 in above normal. The average monthly precipitation during the period was somewhat above the 44-year normal for all months excepting January, February, July, and December.

During the 14-year period the run-off varied from 12 per cent of the rainfall for the bluegrass sod to 30.7 per cent for the land plowed 4 in deep and kept in cultivated fallow. That from the continuous corn was 29.4 per cent, from the continuous wheat 23.3 per cent, and from the rotation 13.8 per cent, or only slightly more than from the sod. There was very little difference in the run-off from the shallow and deep plowed land, the run-off from the 4-in plowing being only 0.4 per cent above that from the 8-in plowing.

The average annual erosion per acre varied from 41 tons for the land plowed 4 in deep and left in cultivated fallow to the almost negligible quantity of 0.34 ton for the continuous bluegrass sod. The annual erosion from continuous corn was 19.74 tons per acre, or about one-half the amount from the cultivated fallow, that from continuous wheat was 10.10 tons, or about one-half the amount from continuous corn, and that from the rotation was only 2.78 tons or less than one-third the amount from continuous wheat.

The influence of the deep plowing in diminishing erosion losses was almost negligible, the 8-in plowing losing annually only 0.56 ton per acre less soil than the 4-in plowing. From the conditions of this investigation, therefore, the results fail to substantiate the common belief that deep plowing is markedly better than shallow plowing in erosion control.

Expressing these erosion losses in terms of years required to remove the surface 7 in, or the so-called "plow soil," they would represent only about 24 years for the cultivated fallow land, 50 years for continuous corn, 100 years for continuous wheat, 368 years for the rotation, and a little over 3,000 years for the continuous bluegrass. During the six months of the corn production season, April to September, the erosion loss from continuous corn averaged 4.7 times that from corn grown in the rotation of corn, wheat, and clover. Similarly the run-off from the continuous corn was 2.5 times that from the rotated corn.

The number of units of run-off water necessary to remove one unit of soil varied from 34 for cultivated fallow to 1,666 for continuous sod. In general the units of run-off necessary to remove a unit of soil from the cultivated land was much less than from the cropped land.

A four-year experiment with soybeans in rows 3.5 ft apart, running with the slope, and an experiment of similar length with soybeans drilled 8 in apart (all beans fallowed by a rye cover), showed that the run-off from the beans in rows was 84 per cent and that from the drilled beans 74 per cent of the run-off from continuous corn during the same years. Similarly the erosion from the beans in rows was 94 per cent and from the drilled beans 43 per cent of that from continuous corn.

The annual losses of plant nutrients in the eroded soil from continuous corn or wheat, as determined during a two-year period, were shown to be as great as or greater than those through the crop grown, but under a good cropping system or grass these erosion losses were in most cases reduced to amounts much less than those through crops.

Mechanical analyses of the eroded material from the different plats showed that the uncropped plats and the one in corn lost more sand than the others due evidently to the greater velocity of the run-off water on the bare soil surface.

GREENHOUSE HEATING, *A. H. Senner* (U. S. Dept. Agr. Circ. 254 (1932), pp. 40, figs. 26). This circular gives technical information relating to the design and improvement of greenhouse heating plants. It presents standard engineering data on the subject together with practical information on the layout and operation of modern greenhouse heating systems.

FILLING SILOS WITH THE FIELD ENSILAGE HARVESTER, *A. J. Schwantes* and *J. B. Torrance* (Minnesota Sta. Bul. 290 (1932), pp. 27, figs. 6). The results of a study of field silage harvesters are reported which included 14 machines used on 35 farms. Two and one-half farms and 37.3 acres was the average per machine in 1930. A capacity of about 7.5 tons, or about 1 acre per hour, might reasonably be expected under normal conditions. In most cases one man handled the silage harvester and the tractor or horses. An average of 3.6 men were employed hauling the silage from the field to the silo. On most farms one man remained at the silo to assist in unloading. In about one-third of the cases a man worked in the silo.

Four teams were used for hauling silage on one-half of the farms. On about one-third of the farms three teams were used. The power unit for operating the blower may be smaller than that required to operate a stationary silo filler. In the field a 3-plow tractor is needed to operate the field ensilage harvester. This is more than is necessary for the corn binder.

The average estimated life of the field silage harvester was 10.8 years and of the blower 20 years. The total cost per acre of filling silos with the field silage harvester is $7.83 and the cost per ton is $1.07, based on a yield of 7.3 tons per acre and a charge of 30 c per hour for man labor and 12.5 c per hour for horse work. The cost of operating a 2-plow tractor was assumed to be 74 c per hour and that of a 3-plow tractor 96 c per hour. Labor costs are somewhat less with the field silage harvester method of filling silos than with the stationary silo filler method, but power and machinery costs tend to be about the same. There is no significant difference in total costs of the two methods. The field silage harvester equipment requires a cash layout about 27 per cent higher than that for the corn binder and silo filler.

SOME FACTORS AFFECTING MECHANICAL REFRIGERATION FOR DAIRY FARMS, *T. E. Hienton* and *E. H. Parfitt* (Indiana Sta. Bul. 363 (1932), pp. 8, figs. 3). Studies are reported which showed that the average current consumption for 100 lb of milk cooled per degree Fahrenheit by three dry-box milk-cooling installations operated for one year was 0.064 kwh. The average current consumption for cooling 100 lb of milk by two storage-tank type milk-cooling installations operated for more than one year was 0.041 kwh.

Heat losses per 24 hours per square foot per degree temperature difference varied from 4.24 to 3.13 Btu in five insulated milk tanks

studied. Heat losses are dependent upon the amount of insulating material used in the construction of the storage box.

Of the temperatures studied, 45 deg was found to be the most satisfactory at which to operate a milk-cooling tank to inhibit bacterial development during a storage period of from 12 to 14 hours. Precooling of milk over a surface cooler to 70 deg was found to show no bacterial advantage when compared with milk not surface cooled but placed immediately in the cooling tank, but did result in less use of energy by the refrigeration unit. Agitation of the cooling medium in a wet storage tank by means of a mechanical agitator increased the rate of cooling of milk not surface cooled, but caused no significant difference in the bacterial count of the milk from that cooled in tanks not agitated. The rate of cooling was faster with the use of a surface cooler than where milk, not surface cooled, was cooled in the tank and cooling water agitated for 2 hours, but there was no significant difference in bacterial counts.

[AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE OHIO STATION], *R. C. Miller, N. R. Bear, C. O. Reed, R. M. Salter, V. L. Overholt, E. A. Silver, G. W. McCuen, M. A. Bachtell, W. E. Weaver, J. S. Cutler, and H. S. Elliott* (Ohio Sta. Bul. 516 (1933), pp. 101-106, 108, 110, 111, fig. 1). The progress results of investigations on corn storage, effect of seedbed preparation on corn yield, corn planters, drainage, feed mills, threshing machines, hay chopping, soil chisel and mole drainage, and methods of handling hay are briefly reported.

[AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE CALIFORNIA STATION] (California Sta. Rpt. 1932, pp. 21-27, figs. 5). The progress results of investigations on brooders and poultry houses; farm buildings and equipment; farm machinery, including cotton harvesters, crusher mowers for hay, hay choppers, and cross blockers for beets; machinery and fire for controlling weeds and insects; fire prevention; soil heaters; and orchard heaters are briefly reported.

[AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE IOWA STATION], *J. B. Davidson et al* (Iowa Sta. Rpt. 1932, pp 15-18, figs. 2). The progress results are briefly presented of investigations of corn-production methods, farm building losses due to wind and fire, the all-masonry barn, farm refrigeration, wind electric power plants, the use of tractors, and tractor track efficiency.

[AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE INDIANA STATION] (Indiana Sta. Rpt. 1932, pp. 14-17, fig. 1). The progress results are briefly presented of investigations on the combined harvester-thresher, soil erosion prevention by Mangum terraces, management of air-cooled apple storage, temperature and humidity in poultry houses, the field ensilage harvester, the hay and grain drier, mechanical corn production, low corn cutting, clean plowing accessories, mechanical corn picker losses, electric soil heating, electric dairy water heaters, power consumption of stationary and portable methods of spraying, and the value of grinding grains for dairy calves.

GOOD POULTRY EQUIPMENT—ONE OF THE SHORT CUTS TO GREATER POULTRY PROFITS, *J. M. Moore* (Michigan Sta. Quart. Bul., 15 (1933), No. 3, pp. 197-204, figs. 11). Various types of poultry equipment are described and illustrated, including mash hoppers, watering equipment, shades, and catching crates.

RURAL ELECTRIFICATION IN OKLAHOMA: A STUDY OF CONSUMPTION AND COSTS, *E. R. Miller* (Oklahoma Sta. Bul. 207)1932), pp. 135, figs. 47). The results of a consumption and cost study conducted by the station in cooperation with the Oklahoma Committee on the Relation of Electricity to Agriculture and the Oklahoma Utilities Association are reported. For this study 22 typical electrified farms located in various parts of the state but within a radius of 125 miles from Stillwater were selected. These consisted of dairy, poultry, and general farms.

Detailed data are given relating to the use of electricity on these farms for lighting, pumping water, cooking, household and dairy refrigeration, heating water, laundering, operating dairy equipment, incubation and brooding, feed grinding, and silage cutting.

GRINDING AND ELEVATING GRAIN WITH A ½ HP MOTOR, *H. J. Gallagher* (Michigan Sta. Quart. Bul., 15 (1933), No. 3, pp. 146-151, figs.3). Practical information and working data are given on the subject.

EXPERIMENTS WITH ELECTRIC WATER HEATERS FOR POULTRY, *T. E. Hienton* and *C. W. Carrick* (Indiana Sta. Bul. 367 (1932), pp. 12, figs. 7). Experiments are reported which showed that electric heaters of proper capacity offer a satisfactory method for preventing freezing in poultry drinking vessels. An electric heater of more than 30-w capacity was required to prevent freezing in a 14-qt bucket at temperatures below 15-deg F, under conditions prevailing during the tests. An 8-gal fountain required a heater of more than 75-w capacity to prevent freezing in zero weather or below. Water in similar vessels froze at higher temperatures with external heaters than with immersion heaters of the same wattage. External heaters equipped with 3-heat switches used less total current than did immersion heaters having the same wattages as those of the former at high heats. Fountain warmers should be slightly larger than the bases of the fountains which they heat to prevent freezing of water in the troughs.

HEATING THE FARM HOME, *A. H. Senner* (U. S. Dept. Agr., Farmers' Bul. 1698 (1933), pp. 11+18, figs. 7). This bulletin supersedes Farmers' Bulletins 1174 and 1194. It discusses the requirements that should be met and the characteristics of different types of heating systems, and gives advice on selecting heating plants for farm homes and on ways of conserving heat.

FACTORS AFFECTING THE PERFORMANCE OF KEROSENE COOK STOVES, *E. B. Snyder* (Nebraska Sta. Res. Bul. 64 (1932), pp.22, figs. 5). The purpose of this investigation was to learn the effect of constructional details of the burner and the framework on the performance of kerosene stoves. Six stoves were used, four of the long-chimney type and two of the short-chimney type. Of the short chimneys one burner used a wick, the other a lighting ring. The effect of (1) draft variations and constructional details and (2) the framework on the heating time and thermal efficiency of stoves was studied.

The results show that the draft of long-chimney burners is greater than that of short and is affected by the height and diameter of the chimney and the size and arrangement of openings for air. Because of the greater draft in long-chimney burners the rate of combustion is higher, resulting in a more powerful but slightly less thermally efficient burner than the short.

Differences in performance of long-chimney burners are due to such constructional details as height and diameter of chimney, size and arrangement of openings for air (particularly in the flame spreader), angle of collar on which the chimney rests, and the distance between the flange and the top of the flame spreader. Such features are fundamental because they direct air currents and mix air with kerosene vapor.

No improvement in heating time and thermal efficiency resulted from interchange of chimneys on long-chimney burners from the same manufacturer. The best results were obtained with the original combination. One combination was slightly superior in performance to the other three. An increase in chimney diameter on one short-chimney burner decreased the heating time but lowered the thermal efficiency. The performance of burners in the cabinet was generally superior to the performance on the stoves. These results suggest the importance of insulation of burners.

Relative distance of grate from chimney top affected heating time and thermal efficiency. Heating time decreases and thermal efficiency increases as the distance between grate and chimney top decreases. However, there appears to be an optimum distance for each burner because less than this distance results in the formation of soot and odor. The shape and weight of the grate and elevations on it are important factors affecting burner performance. Enclosure of the sides and back improves burner performance, especially where the stove is exposed to outside draft. Long chimneys are not affected by draft to the extent that short chimneys are.

[AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE EVERGLADES SUBSTATION] (Florida Sta. Rpt. 1932, pp. 164-167, 196-198, figs. 2). The progress results of studies of water control in soils being conducted in cooperation with the U.S.D.A. Bureau of Agricultural Engineering are briefly reported.

[AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE KANSAS STATION] (Kansas Sta. Bien. Rpt. 1931-32, pp. 45-47, 119, 120). The progress results are reported of studies on the influence of method of harvesting and baling alfalfa hay on quality and on the efficiency of the combined harvester-thresher for harvesting grain sorghums, by *F. L. Zink;* the effect of the method of storing combined wheat upon quality, by *F. C. Fenton* and *C. O. Swanson*; and soil erosion and moisture conservation.

TRACTOR AND HORSE POWER IN THE WHEAT AREA OF SOUTH DAKOTA, *C. M. Hampson* and *P. Christophersen* (South Dakota Sta. Circ. 6 (1932), pp. 39). The data discussed in this circular indicate that many farms in the wheat area of South Dakota are not operating their separate power units at their maximum efficiency. The low efficiency units are represented by the tractors which consume more fuel and oil per 10 hours than the averages, by the horses which are fed more than the average of other horses doing a similar amount of work, and by tractors and horses that perform less wórk per 10 hours than the most common performances. Even the averages are not to be considered the optimum of efficiency, since many teams and tractors do better than the averages, and since the averages include power units which were operated with less than their respective optimum loads.

The efficiency of tractors may be improved and the cash costs of operation reduced by making needed repairs and adjustments, by using proper hitches, by operating with an optimum load, and by good bargaining for fuel and oil. Efficiency of horses may be increased and the costs reduced by having harness and implements in best adjustment, by using proper hitches and loads, by economical feeding, and by using mostly young horses. Farm power costs may be further reduced by less threshing of feed crops and by harvesting more of the feed crops with livestock.

Many farms in the South Dakota wheat area do not have the best possible power combinations. Adjustments to secure such combinations frequently involve considerable changes in amounts of land, labor and capital, and a period of several years. Increasing the crop acreage of farms would reduce the total costs per acre of the power units thereon, and on many farms the increase would make the power units more effective. If the added acreage could be secured with small cash outlay, the net returns to the farm might be enhanced also. A partial shift from the use of a large tractor to more use of a smaller one or a shift from tractor as major power to horses as major power would be desirable on some farms during periods of low prices for farm products. Net returns to the farm business over a period of years should determine any adjustments which would be effective for a long time. Under normal economic conditions net returns are of greater importance than the temporary lowering of cost per unit of power, per unit of land, per laborer, or per unit of product.

Information is also given on adjustment and utilization of farm power under conditions similar to 1932.

[IRRIGATION INVESTIGATIONS AT THE NEW MEXICO STATION] (New Mexico Sta. Rpt. 1932, pp. 73-80). The progress results are reported of investigations on duty of water, rate and cause of rise of ground water in the Mesilla Valley, potato culture under irrigation, water requirements and the economical use of water for cotton and other crops, rainfall supplemented by underground water in the production of crops of low water requirements, and the effect of fertilizers and frequency of irrigation on the yield and the keeping and marketing qualities of th Early Grano onion. These investigations are being conducted in cooperation with the U.S.D.A. Bureau of Agricultural Engineering.

V-BELT DRIVES FOR FARM MOTORS AND EQUIPMENT, *H. Beresford* (Idaho Sta. Circ. 70 (1932), pp. 14, figs. 11). This circular reports one of a series of studies conducted by the station in cooperation with the Idaho Committee on the Relation of Electricity to Agriculture.

It has been found that V-belt drives for farm motors and equipment are efficient, flexible, and well adapted to most belt-driven farm machinery suited to electric motor power. High reduction or increased ratio drives are obtained with V-belts at a minimum expense and economy of space. The power transmission capacity of a multiple V-belt drive may be increased by addition of individual belts or strands. Combination V-grooved drives and flat-driven pulleys on portable farm motors and farm machines permit a convenient and satisfactory drive for reduced speed ratio needed on silage cutters, hay choppers, and similar machines. V-belts are not adapted to operation under temperatures above 120 deg F, or where oil or grease is prevalent.

DAILY RIVER STAGES AT RIVER GAGE STATIONS ON THE PRINCIPAL RIVERS OF THE UNITED STATES, compiled by *M. W. Hayes* (U. S. Dept. Agr., Weather Bur., Daily River Stages, 29 (1931), pp. III+165). This volume, containing the daily river stages for 1931, is the twenty-ninth

of a series of daily river stages on the principal rivers of the United States.

THE SEPTIC TANK, *E. R. Gross* (New Jersey Stas. Circ. 267 (1933), pp. 4, figs. 3). Practical information is given on the planning and construction of small sewage-disposal systems for isolated residences. These include treatment by septic tank and tile absorption area.

[IRRIGATION INVESTIGATIONS IN OREGON] (Oregon Sta. [Pamphlet, 1933], p. 12; Branch Sta. [Pamphlets, 1933]—Harney Sta., pp. 3, 4, 6, fig. 1; Umatilla Sta., pp. [2-4]). These pamphlets report briefly the outstanding accomplishments resulting from irrigation investigations at the main station; results of experiments on an irrigated 80-acre farm unit under pump and duty of water experiments with several grain, forage, and truck crops at the Harney Substation; and results of studies with strip border method of irrigation and of lysimeter tests at the Umatilla Substation.

[RURAL ELECTRIFICATION INVESTIGATIONS AT THE NEW HAMPSHIRE STATION] (New Hampshire Sta. Bul. 270 (1933), p. 14). The progress results of studies on the total electrical load used on seven experimental farms and on the dry storage of milk are briefly reported.

CORN BORER CONTROL WITH FARM MACHINERY, *H. N. Worthley* and *R. U. Blasingame* (Pennsylvania Sta. Bul. 284 (1933), pp. 19, figs. 9). Studies of corn borer control by the use of machinery are reported, which were conducted in cooperation with the U.S.D.A. Bureau of Agricultural Engineering.

It was less expensive to husk corn from the standing stalks than to cut it, but standing stalks and tall stubble could not be plowed cleanly enough to avoid the hand picking of borer-infested stalks from the surface of plowed ground. Where standing stalks were successfully poled down, while frozen, raked up, and burned, further corn borer control efforts were unnecessary. The cost of these extra operations was nearly balanced by the saving of plowing time in the poled areas. The stalk shaver will doubtless be more generally useful than a drag to break down standing stalks.

It was less expensive to cut corn with a tractor-drawn binder than by hand. A binder hitch causing one tractor wheel to crush a stubble row was an aid to clean plowing. A stationary-knife, low-cutting binder performed as well as a standard binder except in shallow-rooted, drought-stricken corn. It left stubble too short to harbor many borers and saved considerable silage. A husker-shredder saved cost in handling the corn crop and shredded the stalks fine enough to kill borers contained in them. Improved effectiveness of the 14-in general-purpose walking plow resulted from the addition of a looped chain and wire.

In seven out of eight direct comparisons the walking plow equipped with chain and wire gave better coverage of standing stalks than tractor plows with standard equipment. In ten out of twelve direct comparisons tractor plows equipped with experimental covering devices gave better coverage than the walking plow. However, in ledgy places the walking plow could be operated, while tractor plows had to be lifted from the ground. Width, weight, and beam clearance were important factors in the performance of tractor plows.

Among the covering devices tested, a floating coulter, a fixed wide jointer, and a floating trash shield gave sufficient promise to warrant their further development and adaptation to existing makes of tractor plows.

[AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE MAINE STATION] (Maine Sta. Bul. 363 (1932), pp. 265, 266, 294-296, fig. 1). The results of examinations of gasolines and motor oils, by *J. M. Bartlett, C. H. White*, and *B. E. Plummer*, and brief descriptions of a cold storage for apples at the Highmoor Farm and a greenhouse at the main station are presented.

WATER POWER ON THE FARM, *D. S. Weaver* (North Carolina Sta. Agron. Inform. Circ. 74 (1932), pp. 6, figs. 3). Practical information is given on how to develop and utilize water power on farms in the Piedmont and Mountain sections of North Carolina.

A HOMEMADE BRICK BROODER, *D. S. Weaver* and *C. F. Parrish* (North Carolina Sta. Agron. Inform. Circ. 76 (1932), pp. 4, figs. 6). Practical information is given on the construction of a homemade brick brooder together with working illustrations.

TRACTOR FUELS, *E. C. Sauve* (Michigan Sta. Quart. Bul., 15 (1933), No. 4, pp. 287-292). Results of tests of different tractor fuels are briefly summarized.

Results show that gasoline is the most volatile of the petroleum fuels and contains the greatest number of heat units per pound as compared with other fuels. The value of gasoline depends upon the nature of its distillation, and more power will be produced in an engine using a low test gasoline than a high test gasoline. It was also found that the power or efficiency of an engine is not necessarily in direct ratio to the British thermal units of the fuel used. It was found that kerosene and distillate are satisfactory fuels for tractor use when tractors are designed to accommodate them. The investigations seem to indicate that the use of crude oil for tractor fuel is of questionable economy. The most economical fuel for tractor use based on performance and cost was found to be distillate, followed in order by kerosene, gasoline, and alcohol-gasoline blends.

DURABLE FINISHES FOR ANY KIND OF FLOOR, *C. H. Jefferson* (Michigan Sta. Quart. Bul., 15 (1933), No. 4, pp. 282-287, figs. 6). Results of experiments on floor finishes are briefly summarized.

Results indicated that finishes that remain on the surface did not stand up under heavy traffic, but that finishes which penetrated the wood instead of remaining on the surface showed greater durability. It was also found that the penetrating finishes are quickly and easily removed. Badly worn varnish finishes must be removed before a new finish is applied if a smooth uniform surface is to be obtained, and penetrating finishes are not satisfactory over varnish or wax. The water-solvent or no-buff waxes were more easily applied, more durable, and less slippery than the ordinary paste waxes, and the no-buff waxes seemed to be more durable over the penetrating finishes than over varnish. The penetrating finish without a coat of wax was found to be more desirable on kitchen floors, and a thin coat of wax more durable than a thick coat.

MOVABLE HOG HOUSES, *W. C. Skelley* and *E. R. Gross* (New Jersey Stas. Circ. 276 (1933), pp. 4, figs. 2). Practical information is given on the planning and construction of movable hog houses, together with working drawings and bills of materials.

CORNCRIBS FOR THE CORN BELT, *M. A. R. Kelley* (U. S. Dept. Agr., Farmers' Bul. 1701 (1933), pp. II+26, figs. 33). This bulletin presents designs for several types of grain storages adapted to the corn belt.

[AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEBRASKA STATION] (Nebraska Sta. Rpt. [1932], pp. 6, 7, 37). The progress results of studies of wind-driven electric plants, pump irrigation, the use of electric power on farms, electrically operated farm refrigerators, the use of small motors on the farm, and methods of cooling milk on the farm and their effect on quality are briefly reported.

THE QUALITY OF WHEAT AS AFFECTED BY FARM STORAGE, *C. O. Swanson* and *F. C. Fenton* (Kansas Sta. Tech. Bul. 33 (1932), pp. 70, figs. 27). The results of a study of the quality of wheat and the methods of preventing damage while in storage are reported, which was conducted by the departments of agricultural engineering and milling industry of the station.

It has been found that damage to the quality of combined wheat results from storing with a sufficient moisture content to cause heating which is usually accompanied by molding. Too much moisture in wheat may result from combining too early, from immature wheat in low spots in the field, or from rain or dew. Excessive heating is more likely to take place if the temperature of the wheat is abnormally high when it is placed in the bin. Continued hot weather soon after storing also promotes heating of the wheat. It has also been found that heat diffuses slowly in wheat, and that hot pockets may develop from loads of high-moisture or high-temperature wheat. Small amounts of damp wheat are less likely to be damaged if mixed and stored with dry wheat. Natural respiration in normally dry wheat brings about an improvement in the baking value of the flour. However, if the moisture content is too high, a lowering of the milling and baking value takes place.

The storage studies showed that the type of material used in bin construction is of less importance in preventing damage to the wheat than the type of ventilation used in the bin. Ventilation to be effective must cause enough air movement to cool the wheat and remove excess moisture. A type of ventilator which does not accomplish this promotes damage rather than prevents it, because it tends to condense moisture and brings in enough oxygen to support mold growth. Of the natural methods of ventilation tried, that which permits the passing of the air upward through a perforated floor gave the best results. Another effective method of natural ventilation was by means of perforated side walls and a large perforated central flue with a suction cupola on top. It was also found that heating wheat may be cooled and lowered in moisture content by transferring from one bin to another.

In experiments conducted during 1931 it was found that forced ventilation was more effective in cooling the wheat than natural ventilation. While the evidence comparing suction of air with forcing of air was limited, the indications were that forcing was more effective than suction. It was also found that the temperature of wheat stored in ventilated bins approximated the outside air temperatures more closely than that stored in unventilated bins.

NEBRASKA TRACTOR TESTS, 1920-1932 (Nebraska Sta. Bul. 277 (1933), pp. 31, fig. 1). This bulletin summarizes the results of 74 tractor tests and includes data on all tractors reported by their manufacturers as on the market January 1, 1933.

WIND ELECTRIC LIGHTING PLANTS, *E. G. McKibben* and *J. B. Davidson* (Iowa Sta. Bul. 297 (1933), pp. 261-275, figs. 7). This is a summary of investigations made to determine the possibilities and limitations of the wind electric plant under Iowa farm conditions. It is based on the results obtained from several years' investigations and one year's operation, under test, of a wind electric plant located at the station and from a study of the performance of 66 wind electric plants on Iowa farms.

It has been found that where properly installed, equipped, and managed, wind electric plants on Iowa farms are satisfactorily supplying electricity for lighting and small household appliances. During a year's trial at the station a wind electric plant produced 842 kwh, and during 10 months of the year the monthly energy production was over 50 kwh. During September however it was only 31.2 kwh and during August, 11.3 kwh.

It appears that the tower should be from 10 to 25 ft higher than surrounding buildings or trees, although the exact tower height is said to be still a matter of judgment rather than mathematical calculation. Unless the plant is very lightly loaded, at least a 240-ah (ampere-hour) battery will be needed, and under many conditions a 300 to 400-ah battery will be more satisfactory.

The advantages of this type of lighting plant over an engine-driven plant are enumerated as (1) no fuel cost; (2) almost no routine attention; and (3) absence of noise, vibration, grease, and odors. The disadvantages are (1) higher first cost, (2) limitation of generator output by the wind available, (3) maintenance of a larger battery, and (4) the necessity of occasionally climbing the tower.

The conclusion is that any development which would decrease the first cost of the plant, decrease the cost per unit of storage capacity of the batteries, or increase the useful life of the batteries, would materially improve the economic position of the wind electric plant.

RECENT FINDINGS IN TRACTOR ENGINE LUBRICATION, *E. A. Hardy* (Sci. Agr., 13 (1933), No. 6, pp. 395-402). The results of investigations on tractor engine lubrication conducted at the University of Saskatchewan are briefly summarized.

It has been found that oils used in internal-combustion engines can be reclaimed and used again. The method of reclaiming may vary from straining the oils through canton cotton, blotting paper, or felt strainers to the use of filters consisting of layers of soils and sand, or leaving the oil in barrels for long periods of time so that the heavy particles will settle to the bottom. The function of reclaiming the oil is to remove the dirt and water from the oils. No attempt is being made to remove the dilution caused by heavy fuels ends accumulating in the oil.

The lightest oils which may be operated in the engine without excessive oil pumping should be used. The oil should be strained each day and used over again and new oil be added to the crankcase to maintain the proper level, where the engine is not equipped with an oil filter. A portion of the used oil should be mixed with the fuel for use during at least the first 20 minutes of operation. Great saving in engine opera-

tion can be effected where excessive wear is eliminated and the operating efficiency of the engine is increased.

THE HOUSING OF POULTRY, *I. Rhys* ([Gt. Brit.] Min. Agr. and Fisheries Bul. 56 (1933), pp. V+36, pls. 8, figs. 40). This is the third edition of this bulletin.

THE FINANCIAL REHABILITATION OF IRRIGATION AND DRAINAGE DISTRICTS, *G. E. P. Smith* (Arizona Sta. Bul. 144 (1933), pp. 121-142, figs. 2). This bulletin discusses the historical and legal aspects of irrigation in Arizona, and lists the districts with areas and indebtedness. The effects of the depression are discussed with reference to price levels, farm losses, land values, and tax delinquency, and the position of the bondholders is presented with reference to legal remedies. It is suggested that the best solution is to compromise. Steps in reorganization are presented.

POWER ALCOHOL, compiled by *D. W. Graf* (U. S. Dept. Agr., Bur. Agr. Engin., 1933, pp. 29). This is a bibliography of references on the use of alcohol as motor fuel and for related purposes.

COLD FACTS, *B. G. Danner* (Ga. Agr. Col. Bul. 433 (1933), pp. 23, figs. 3). This bulletin considers some of the factors governing the use and care of the refrigerator which will increase the efficiency and prolong the service for food preservation and dessert freezing.

STATIONARY SPRAY PLANTS IN GEORGIA, *T. J. Harrold* and *H. E. Lacy* (Ga. Agr. Col. Bul. 429 (1933), pp. 28, figs. 11). The information reported in this bulletin was developed from studies conducted at the college and from data secured from 13 orchards to determine what contribution the proper utilization of stationary spraying equipment and machinery might make to efficient and profitable orchard production. From this information engineering data are presented on the planning, installation, and use of stationary spraying plants.

ELECTRIC STEAM STERILIZATION AND WATER HEATING IN THE DAIRY ([C.R.E.A.] Natl. Rural Elect. Proj., College Park, Md., Rpt. 7 (1933), pp. 40, figs. 51). This publication presents practical information on the use of electricity for heating purposes in dairies and on the selection of sterilizing and water heating equipment best suited to different farm conditions and electric rate structures. Such equipment is described, and its characteristics, adaptability, and approximate cost stated briefly.

The results of tests of a controlled steam sterilizer and of bacterial reduction in steam sterilizers are reported. It was found that scalding, boiler steam sterilization, and controlled steam sterilization were approximately equal in effectiveness in reducing bacterial counts under carefully controlled conditions.

THE COMBINE HARVESTER IN GEORGIA, *H. E. Lacy* and *W. A. Minor, Jr.* (Ga. Agr. Col. Bul. 428 (1933), pp. 28, figs. 13). Results of a survey of 24 combines in Georgia are reported. These have been used successfully for harvesting wheat, oats, rye, and soybeans in the state. It has been found that the losses are about one-half as much as for the binder-thresher method, these being about 3 per cent for the combine and 6 per cent for the binder-thresher. The estimated life of the combine in Georgia is 9.4 years. Green weeds tended to choke the combine and add moisture to the threshed grain.

The study indicates that in Georgia the farmer should have from 100 to 150 acres of small grain in order to justify a 10 or 12-ft combine. The per acre cost of harvesting was found to decrease as the acreage harvested increased, the cost being $2.02 when 200 acres per machine is harvested, $1.47 when from 200 to 400 acres are harvested, and $0.82 when more than 400 acres are harvested. The average cost of harvesting with the combine in the 24 cases studied was $1.75 per acre as compared with $3.04 for a mule binder.

A THREE-ROW NURSERY PLANTER FOR SPACE AND DRILL PLANTING, *O. A. Vogel* (Jour. Amer. Soc. Agron., 25 (1933), No. 6, pp. 426-428, fig. 1). In a contribution from the U.S.D.A. Bureau of Plant Industry, a 3-row nursery planter is described and illustrated which will sow one or three rows as desired and space-plant wheat kernels at various intervals or drill them at various rates. A feature of the planter is that it will seed to the last few kernels and that nearly as many rows of wheat can be planted as drilled within a given period.

INSULATION ON THE FARM (Washington: U. S. Dept. Com., Natl. Com. Wood Util., 1933, pp. VI+49, figs. 44). This is a report of the subcommittee on insulation on the farm of the National Committee on Wood Utilization. Its purpose is to point out to farmers how to select the proper type of insulating material for any particular requirement and how to install it to the best advantage.

ELECTRIC SOIL STERILIZATION, *A. V. Krewatch* and *G. W. Kable* ([C.R.E.A.] Natl. Rural Elect. Proj., College Park, Md., Rpt. M-15 (1933), pp. 12, figs. 6). The results of studies of the practicability of the resistance method of soil heating conducted by the National Rural Electric Project in cooperation with the Maryland Agricultural Experiment Station are reported.

In general, the conclusion is drawn that the resistance method may be used with reasonable safety and satisfaction for sterilizing soils in a specially built sterilizing box. It may also be used in bench soils where conditions are uniform and the operator has acquired the technic for his particular conditions.

The equipment necessary for sterilizing in benches or beds consists of sheet metal plates to be used as electrodes, two-wire cable, clips for connecting the cable to the plates, and a reliable glass thermometer. The plates are inserted vertically in the soil across the bed at regular intervals, and each successive plate is connected to opposite sides of a 230-v circuit. The size of plates is determined by the width and depth of the soil in the bench, and the number and spacing by the capacity of the circuit, the moisture, and the soil type.

It was found that the power demand varied widely with different types of soils, soil moisture content, soluble salts in the soil, and increasing temperature during sterilization. Contact resistance between soil and plates tended to accelerate heating at the plates, drying the soil, and stopping the flow of current. Current leakage from the plates to the ground in grounded beds stimulated drying at the plates and made sterilization almost impossible without cutting transformer and service grounds.

A cover made of a double thickness of black mulch paper placed over one half of the bench resulted in an increase of temperature of 10 deg F in the body of the soil, 66 deg in the surface soil, and 36 deg at the edge of the bench. In the uncovered section the temperatures started dropping before the surface and edge temperatures reached 180 deg.

The power necessary for sterilization in a ground bed with the electrical ground disconnected was greater than in benches, the range being between 40 and 50 kwh per cubic yard in comparison with from 30 to 40 kwh per cubic yard in the bench, or from 25 to 30 kwh in the box sterilizer. Under the best conditions the sterilization of ground beds, in addition to using more power, was less satisfactory than soil in benches because of the longer heating period with the accompanying drying at the plates.

INDUSTRIAL, AGRICULTURAL, AND DOMESTIC APPLICATIONS OF ELECTRICITY, INCLUDING ILLUMINATION AND TARIFFS, *R. B. Matthews* (Jour. Inst. Elect. Engin. [London], 72 (1933), No. 434, pp.132-140). This report includes among other things a discussion of recent applications of electricity to agriculture, such as for lighting of homes and poultry houses, heating, meeting general power requirements, operation of liquid manure pumps, milking machines, and barn machinery and hay drying.

CORROSION OF METALS IN SALT SOLUTIONS AND SEAWATER, *G. D. Bengough* (Jour. Soc. Chem. Indus., Chem. and Indus., 52 (1933), Nos. 10, pp. 195-210, figs. 22; 11, pp. 228-239, pls. 4, figs. 18). Studies on the measurement of corrosion are reported, which were confined to stagnant salt solutions.

It is pointed out that the most important or controlling factor is that one which permits the slowest rate of corrosion. A machined surface is considered preferable to one emeried or polished because of the ease, rapidity, and uniformity of production, particularly at the edges, and because it is believed to be less contaminated and more reproducible. It is useful to adopt a constant surface area for specimens.

It has been found that increased cross section of the vessel containing the solution increases the corrosion rate with both zinc and steel. Typical corrosion-time data for zinc and mild steel are presented graphically, together with data on the distribution of corrosion on both metals. With steel it was found that the starting points of corrosion were sporadically distributed and very numerous. There was usually a cessation of corrosion, after an hour or two, at a very large number of the points, but persistence at others which seemed to be fairly sporadically distributed. The cessation appeared to be due to suppression of the less active points by films formed by alkali resulting from action at the most active.

A process of aggregation began after a few hours which resulted in the formation of a few large attacked and unattacked areas. These were continued around the disks from one surface to another, owing to the creeping of alkali.

The configuration of the corroded areas was decided early in the process in dilute solutions, and spreading thereafter was very slow, probably owing to the formation of impervious walls between the attacked and protected areas, which hindered interaction of corrosion products close to the metal surface. Spreading increased with concentration.

Penetration was deeper in dilute solutions for periods up to about one year. The depth of penetration was usually found to be greater on the bottom surfaces of steel, and especially deep at or near the position of the glass points which supported the specimen.

Studies of factors which control distribution of corrosion showed that it is governed on both steel and zinc by at least four factors, namely: (1) The distribution of films of corrosion products possessing protective properties which might be either long continued (with steel) or ephemeral (with zinc); (2) the tendency of alkali to creep away from its principal seat of formation (at and near the water line) down into the interior of the liquid, and so cause protection there; (3) the special reactivity of edges at which corrosion started and then spread inward at varying rates—spreading could take place toward either more, equally, or less aerated parts of the metal; and (4) the tendency of heavy metallic salt to fall, and so to neutralize alkali and cause corrosion to spread downward from a given starting point.

LIGHTNING PROTECTION OF DISTRIBUTION SYSTEMS AND TRANSFORMERS, *C. S. Sprague* and *C. F. Harding* (Purdue Univ., Engin. Expt. Sta. Res. Ser. 42 (1932), pp. 89, figs. 38). This bulletin presents the results of a 4-year experimental investigation of the effect of potentials, simulating those of lightning, upon 2300-4000 to 115-230-v electric light and power distribution systems. In general the work was centered upon the secondary distribution system, the distribution transformer, and the consumer's wiring circuit, as lightning damage commonly manifests itself at these points.

The major part of the investigation has been performed upon several spans of outdoor distribution line built especially for the project. This line was constructed in accordance with the specifications frequently used in practice for 4-wire, grounded Y, 2300-4000-v primaries on the upper arm and with three-phase, 230-v power secondaries and single-phase, 115-230-v, three-wire lighting secondaries on the lower arm. The majority of the results obtained are not, however, necessarily restricted to this one type of construction.

Accounts of a few surge tests upon transformers of other manufacturers than those of the original project are also included.

The value of an experimental wood pole distribution line with an insulated artificial cloud charged by means of a surge generator was definitely established for lightning protective investigations involving induced as well as direct-stroke potentials. The practicability and economy of studying, by means of such laboratory equipment, the operation of various transformer, lightning arrester, and ground connections, when exposed to surges approximating those of lightning, were demonstrated.

Efficient primary protection upon an overhead distribution system affords a considerable degree of protection to secondaries located below the primaries. A well-grounded secondary neutral wire acts to reduce potentials to ground on adjacent wires. With existing transformer design, the insulation of the secondary winding may be considerably overstressed by steep wave front surges without excessive stress on the primary insulation. Such secondary stresses may be relieved by improvements in secondary insulation. Low ground resistances, although desirable in other respects, do not necessarily reduce the initial potentials which may be induced upon the system. A noninductive load in the consumer's premises reduced the potentials from 60 to 70 per cent at the service entrance.

Tests, involving both induced voltages and direct strokes, have

(Continued to page 321)

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RAYMOND OLNEY, Editor

R. A. PALMER, Associate Editor

Agricultural Engineers and the New Deal

"IT IS important that the agricultural engineer be impressed upon the consciousness of the New Deal. If he does not look out for this himself, he will meet the common fate of engineers—to be shouldered aside in the encounter with the keen opportunist."

Since the New Deal ceased to be a political password and grew into the dignity of a national program, the time has passed for agricultural engineers—including those in public employ—to pursue a non-partisan or non-committal policy. Whatever were our ideas before, now that the die is cast the least that we can do is to give the New Deal the benefit of our training and judgment. If the job is to be done, it should be done well, and the millions or billions of the public's money invested efficiently. It is a job for engineers, not for opportunists.

Most engineers, and we might say the best engineers, are by nature neither inclined nor qualified to elbow for position and influence with the opportunist. Being temperamentally unsuited for doing our elbowing individually and instinctively, the public interest and our own alike demand that we do it collectively and deliberately. Both as an organized Society and as colleagues of one another we should work for the embodiment of agricultural engineering principles in programs of public works, and for the appointment of agricultural engineers to posts for which they are fitted.

The new concentration of power in the hands of public officials, many of them in positions newly created, implies a similar concentration of clamor for their attention. Demands for immediate action forbid any tedious searching for men and methods. In their haste to get out of the woods they are not likely to find the path to the door of the man who makes the better mouse-trap. It is not a time for too much modesty.

While our Society is quite different from a trade association, the recognition which the New Deal accords to such associations shows plainly its respect for occupational organization. Evidently the most effective work we can do for our profession is through our Society. It is a time for outstanding technical programs, well-attended meetings, active progress by technical committees, and for addition to our membership of duly qualified men. It was in urging such efforts that a prominent member of the Society and of the profession made the remarks quoted in the first paragraph above.

Emphasize Erosion Control

AMID our preoccupation with present problems, and in face of the general hue and cry against all so-called reclamation as a presumed means of expanding a seemingly overexpanded agricultural production, a few facts should be borne in mind by all agricultural engineers, and shouted from the housetops for public understanding.

Forced production for immediate revenue by a distressed agriculture is not likely to guard against erosion. Mere idleness of land is likely to accelerate erosion. Terracing and cover-cropping to prevent erosion may easily interrupt or reduce current production at the same time that they preserve our one irreplaceable resource—the soil—for the sustenance of posterity. Erosion control employs labor, machinery, fuel. It serves the present and protects the future.

Hippocratic Ethics for Engineering

FRANK R. INNES, of the editorial staff of "Electrical World," is quoted as offering this suggestion:

"Sometimes I think that the engineering profession needs a creed like the Hippocratic oath of the medical fraternity to which members of the profession can give their allegiance as to a shining ideal of conduct. Such a creed would bind every engineer vigorously to fight against, and to make every effort to expose, the fallacies of uneconomic projects of any kind."

Perhaps most agricultural engineers would be willing to subscribe to this basic idea of public responsibility in professional ethics, even if they differ with Mr. Innes on some of the specific projects which he proceeded to cite in illustration of his doctrine. Indeed, his very criticism brings the issues (such as flood control) into the forum of intelligent debate, and opens the way for agricultural engineers to express their more thorough grasp of the matter.

Nearly all engineers have become experts through training in colleges or universities supported by public funds, or endowed for public benefit. Many—and this is particularly true of our own profession—have seasoned their judgment by experience in public employment. Clearly we have an underlying debt to society, a firm obligation to raise our voices in defense of the general public welfare.

At times this may seem to clash with the engineer's traditional loyalty to his immediate employer, especially in public projects with involved public impacts and perhaps political entanglements. In such case the burden of criticism is properly taken over by colleagues not so silenced. Among the intangible services performed by a professional society such as ours is the fraternizing, at meetings and otherwise, whereby engineers exchange data and opinion from which may come sound criticism.

Agricultural Engineering Digest

(Continued from page 319)

demonstrated that the interconnection of the primary lightning arrester ground with the grounded secondary neutral, effects a considerable reduction in the maximum voltages which may exist across the transformer and imposes no extra hazard upon the consumer's wiring.

From the few tests made on old and dirt-covered transformers, it appears that, if the interconnection is used even these transformers are reasonably immune to lightning voltages. Surge flash-over of secondary racks or service arm brackets should be very rare, since this requires about 100 kv, or approximately ten times the limiting value of key sockets, switches, etc. The extra capacitance of twisted service cable as compared with the open wire service caused only a slight reduction in the voltages at the service entrance.

The recent surge-prooftype distribution transformers provide improvements in bushing design and lead clearances. In some cases, however, there is a possibility of poor coordination between bushing flash-over values and coil insulation puncture values. Reduction of the surge impedance of arrester ground leads is best accomplished by the use of a second ground wire down the opposite side of the pole. The tests of the insulation strength of transformers, when exposed to very high surge potentials without the protective features of coordinating gaps, bushing flashover, or lightning arrester installation, illustrate the importance of maintaining a high ratio of insulation puncture potential to maximum protective potential.

THE PURIFICATION OF WASTE WATERS FROM BEET SUGAR FACTORIES, *E. H. Richards* and *D. W. Cutler* ([Gt. Brit.] Dept. Sci. and Indus. Res., Water Pollut. Res., Tech. Paper 3 (1933), pp. X+157, figs. 15). An account is given of an investigation on the treatment of waste waters from beet sugar factories conducted over a period of 3 years at the Rothamsted Experimental Station and at a commercial beet sugar factory.

An introductory statement describes the processes of the manufacture of beet sugar, with particulars regarding the amount and character of the waste waters produced at each stage. The first part of the report describes laboratory experiments to determine the effects of such factors as rate of filtration, strength of the liquor supplied to the filters, preliminary dilution of diffusion and pulp-press waters with filter affluent, size and nature of filtering material, depth of filter, addition of nitrogen in various forms, and preliminary fermentation to convert part of the sucrose into organic acids.

It was found that diffusion and pulp-press water varies considerably in composition, not only as produced at different factories but also from time to time at the same factory. An average waste water of this type contains from 0.1 to 0.2 per cent sucrose and takes up from 100 to 200 parts of dissolved oxygen per 100,000 in 5 days.

Fermentation with periodic additions of lime did not effect any high degree of purification as measured by the test for dissolved oxygen taken up in 5 days, although it caused a large reduction (over 80 per cent) in the figure for oxygen absorbed from permanganate. In the laboratory experiments on this process, the figure for dissolved oxygen taken up by the treated liquid was not reduced by more than 35 per cent of that for the original waste water.

In the laboratory experiments on the bio-aeration process, an activated sludge was prepared from sewage works sludge and was used for the treatment of an aqueous extract of beet containing 0.1 per cent sucrose. As measured by the test for dissolved oxygen taken up in 5 days, a high degree of purification (over 90 per cent) was achieved on three experiments.

Preliminary experiments on the treatment of diffusion and pulp-press water and solutions of similar composition by the process of biological oxidation on percolating filters demonstrated that a high degree of purification (over 90 per cent) can be effected by this process.

The conditions necessary to achieve 90 per cent purification of diffusion anl pulp-press water by biological oxidation on percolating filters of a depth of about 6 ft are: (1) The waste water should be subjected to sedimentation to remove the major portion of suspended solid matter and diluted to give a liquid equivalent in strength to a solution containing about 0.1 per cent sucrose. The dilution may be effected by river water, effluent from the filters or transport and washing water. (2) The diluted waste water should be filtered at a rate not exceeding 100 or 150 gal per cubic yard of filtering material per day. (3) The most suitable medium for the filters is a hard insoluble material such as gravel, flint, or slag. The material should be graded to a size of about 0.375 to 1 in and should be free from dust.

A study was also conducted of the biological population of the experimental filters. Estimations of the volume and composition of the film and of its sugar-fermenting power were made, and the numbers of organisms of different groups were counted.

A greater volume of film occurred on the finer filter media, and in all cases the film increased during the first 4 or 5 weeks and then remained fairly constant in amount unless sloughing was caused by some external agency. The volume of lm decreased gradually with the depth of the filter.

The organisms present included bacteria, fungi, yeasts, algae, protozoa, rotifers, nematodes, insect larvae, and oligochetes. There was little difference between the populations of the different filters. The smaller organisms reached their full development after 2 or 3 weeks, while the larger ones developed more slowly.

The numbers of organisms decreased on the whole with the depth of the filters except in one or two cases, e.g., testaceous rhizopods and paramecia species, which were more common at the bottom. The protozoa present were largely meso-saprobic forms, and were similar in type to those occurring in sewage filters and in soil. Among the bacteria present in the film there was an appreciable number of nitrogen-fixing organisms.

Inoculation with medium from a sewage works percolating filter made no apparent difference to the purification of the effluent nor to the population developed in the filters, except for the introduction of insect larvae at an earlier stage than occurred in the uninoculated filters.

As far as was observed, a rate of flow up to 300 gallon yard days did not wash organisms out of the filters.

LABORATORY AND FIELD TESTS OF CONCRETE EXPOSED TO THE ACTION OF SULFATE WATERS, *D. G. Miller* and *P. W. Manson* (U. S. Dept. Agr., Tech. Bul. 358 (1933), pp. 80, pls. 9, figs. 22). This is a progress report of experiments conducted in cooperation with the Minnesota Agricultural Experiment Station and the Department of Conservation of the State of Minnesota. It gives results of observations on the behavior of experimental specimens subjected to the action of artificial sulfate solutions in the laboratory and the behavior of specimens installed under natural field exposure conditions in Minnesota, North Dakota, and South Dakota. For this work more than fifty thousand 2-by-4-in cement-concrete and cement-mortar cylinders, 1,000 cement-mortar briquets, 3,000 specially made concrete draintile, and numerous miscellaneous specimens, have been made.

The results indicate that the severity of action on concrete of pure solutions of either magnesium or sodium sulfate increases with the strength of solution, but at a diminishing rate of strengths greater than one per cent. The destructive action of magnesium sulfate does not differ greatly from that of sodium sulfate in solutions of equal strength, although the latter averaged slightly more severe with most of the 35 portland cements used in these tests. The 28-day strength is a fair index of resistance for concrete of any given cement and given curing conditions, but may have no significance for comparing concretes made of cements from different mills or when the concretes are cured under widely different conditions.

Under identical exposure conditions, concrete made of a highly resistant portland cement may last ten times as long as that made of a cement of low resistance. Neither standard physical tests nor ordinary chemical analyses gives any indication of the resistance of a cement to sulfate action. Qualities of the raw material associated with the geological formations from which it comes may be factors in the resistance of a cement.

Resistance of concrete is markedly increased by curing in water vapor at temperatures of from 212 to 350 deg F, almost to the point of immunity to action for the most favorable temperatures and curing periods. Resistance is not increased, however, by raising the curing temperatures until 212 deg is reached, except in connection with the use of certain admixtures.

The admixtures ironite, cal, calcium chloride, blast-furnace slag, trass, moler, and possibly volcanic ash have appreciably retarded sulfate action on concrete cured at room temperatures. Results were outstanding, however, only as the relatively high-curing temperatures of 100 and 155-deg were used in conjunction with Ironite, and 155 deg with cal and calcium chloride. Under these conditions, cylinders had the highly satisfactory values of from 82 to 94 per cent of normal strengths after 5 years in Medicine Lake, S. Dak.

Special cements others than alumina cements have not shown a degree of resistance that would justify preference over the more resistant of the portland cements, except possibly an imported mason's cement containing 33 1/3 per cent diatomaceous silica (moler) mixed with the cement clinker before grinding.

Each of the three alumina cements tested resisted sulfate action to a degree that approached the ideal, but displayed definite indications of instability when used in concretes and mortars stored for long periods in tap water at room temperatures.

A routine test of the resistance of a cement to sulfate action is suggested. This consists in storing one-half of each of the three briquets used in the standard 7-day tensile test in a 5 per cent solution of sodium sulfate and the companion half in a 5 per cent solution of magnesium sulfate. To make these 5 per cent solutions, on the basis of anhydrous salts, requires 3 oz of room-dry salt per gallon of water. Not more than 15 briquet halves should be stored in each gallon of solution, which should be renewed completely every four weeks. It is desirable that the temperature of the solutions be maintained as near 70 deg as practicable. Earthenware jars covered to reduce evaporation are satisfactory and convenient containers.

Briquets made of highly resistant cements and stored under the conditions prescribed will show little or no visible action in either solution in less than 16 weeks, excepting perhaps a slight rounding of the edges. Briquets made of cements very low in resistance, when subjected to this test, will have almost completely disintegrated in 16 weeks. The value of the test will be greatly increased if briquets made of cements from several mills are included in order to give a basis for directly comparing behavior. If this is done, the failure of any cement falling well below the average will be more convincing.

The feasibility of speeding up this 16-week test by increasing the strength of the solution, by keeping the solution at higher temperatures, by using leaner mixes, and in numerous other ways, has been tried without satisfactorily consistent results.

The conclusion is drawn that only cements that are above the average in resistance should be considered for use where sulfates are known to be present. With any given cement and any predetermined conditions of curing, care should be observed in all particulars to obtain the highest practicable 28-day strength.

Concrete should be kept from intimate contact with sulfates until it has had opportunity to dry and harden in air for the longest time practicable. Depending on the particular cement used, air hardening may greatly increase resistance and, as a precautionary measure, should be continued for 30 days if possible, and 90 days or longer is desirable. To develop the highest resistance in draintile, sewer pipe, and other products of concrete, they should be steam cured when from 12 to 24 hours old at temperatures of 212 deg or higher for 48 hours or longer.

Alumina cement may be used advantageously for concrete structures subject to extremely severe conditions of sulfate exposure if the concrete will be continuously moist at temperatures generally below 60 deg and rarely exceeding 70 deg. These moisture and temperature conditions are about the average for draintile after installation.

Literature Received

CATO THE CENSOR ON FARMING. Translation by *Ernest Brehaut.* Columbia University Press, New York, 1933. Cloth, 6x9 in, 156 pp, illus, plates, plans, $3.75. As a picture of rural life in the old Roman republic this book is of exceptional interest. In contrast to the Georgics of a more refined century, Cato's *De agricultura* is a practical book; in fact, it is a handbook upon vine and olive culture, written for any gentleman of means who is about to take up agriculture as a business venture—the only peaceful pursuit, Cato points out, open to such a gentleman. With a few important omissions Cato covers the rural year item by item. He supplies model contracts between owner and harvester, tells how the slaves should be managed and what they should be fed, dictates the religious ceremonies necessary both for pious conduct and for a goodly yield, and even offers remedies (founded upon cabbage as a panacea, with some help from sympathetic magic) for various ills. Detailed notes accompany the translation, and an introduction clarifies the text.

Meeting Program of A.S.A.E. Power and Machinery Division

The Stevens, Chicago, Illinois, December 4, 5, and 6, 1933

First Day — Monday, December 4

Forenoon Session—9:30 to 11:30

SYMPOSIUM: "Seedbed Preparation and Tillage"

(a) "Dynamics of Soil on Plow Moldboard Surfaces Related to Scouring"—M. L. Nichols, agricultural engineer, Alabama Agricultural Experiment Station

(b) "The Status of the Plow Problem" — I. F. Reed, assistant agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture

(3) "Problems of the Plow Manufacturer" — J. P. Seaholm, engineer, Minneapolis-Moline Power Implement Co.

Afternoon Session — 2:00 to 4:00

SYMPOSIUM: "Agricultural Wheel Equipment"

(a) "A Comparative Study of Pneumatic Tires and Steel Wheels on Farm Tractors" — C. W. Smith, professor of agricultural engineering, University of Nebraska

(b) Brief reports on 1933 field tests and observations of the application of rubber tires to tractors and other farm machines, by representatives of state agricultural colleges and farm equipment manufacturers, and by farm machine users.

Evening Program

Committee and Group Round Tables

(Arranged on request)

(a) Committee on Tractor Drawbar Investigations — D. A. Milligan, chairman

(b) Committee on Agricultural Wheel Equipment—H. W. Delzell, chairman

Second Day — Tuesday, December 5

Forenoon Session — 9:30 to 11:30

SYMPOSIUM: "Agricultural and Industrial Engines"

(a) "The Economics of Modern Design in Internal-Combustion Engines" — E. S. Chapman, president, Amplex Mfg. Corp.

Discussion led by (1) A. W. Lavers, chief engineer, tractor division, Minneapolis,-Moline Power Implement Company, and (2) C. E. Frudden, chief engineer, tractor division, Allis-Chalmers Manufacturing Company.

(b) "High-Speed vs. Low-Speed Internal-Combustion Engines" — S. F. Evelyn, chief engineer, Continental Motors Corporation

Discussion led by (1) O. E. Eggen, chief engineer, tractor division, Oliver Farm Equipment Company, and (2) J. C. Keplinger, vice-president, Hercules Motors Corp.

Afternoon Session — 2:00 to 4:00

SYMPOSIUM: "Agricultural Engine Fuels"

(a) "Fuels for Spark Ignition and Compression-Ignition Heavy Oil Engines"—J. B. Fisher, chief engineer, Waukesha Motor Company

(b) "Fuels for Diesel Engines" — R. T. Goodwin and T. B. Rendel, Shell Petroleum Corporation

Discussion led by (1) J. B. Fisher, chief engineer, Waukesha Motor Company and (2) Chas. B. Jahnke, research engineer, International Harvester Company

Evening Program

Committee and Group Round Tables

(Arranged on request)

Third Day—Wednesday, December 6

Forenoon Session — 9:30 to 11:30

SYMPOSIUM: "Garden Tractors"

(a) "Garden Tractor Design from the Standpoint of Field Requirements"—A. A. Stone, head, department of farm mechanics, State Institute of Applied Agriculture on Long Island (New York)

(b) "The Greater Efficiency of Rotary Tillage" —C. W. Kelsey, president, Rototiller, Inc.

Discussion led by E. C. Sauve, assistant professor of agricultural engineering, Michigan State College

Afternoon Session — 2:00 to 4:00

PAPER: "Potato Production with All-Purpose Tractor"—R. U. Blasingame and A. W. Clyde, agricultural engineers, Pennsylvania State College

PAPER: "Handling Check Wire for Wide Planters"—C. K. Shedd, agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture

REPORTS of Committees

Meeting Program of A.S.A.E. Farm Structures Division

The Stevens, Chicago, Illinois, December 4 and 5, 1933

First Day—Monday, December 4

Forenoon Session — 9:30 - 11:30

SYMPOSIUM: "The Farm Structures Handbook Project"—Discussion led by Henry Giese, professor of agricultural engineering, Iowa State College

Afternoon Session — 2:00 - 4:00

SYMPOSIUM: "Economics of Farm Structures"

(1) "The Relation of Income to Housing Costs for Urban Dwellers"—W. G. Kaiser, agricultural engineer, Portland Cement Association

(2) "Farm Building Costs and the Farm Operator's Labor Earnings"—H. B. White, agricultural engineer, University of Minnesota

(3) "The Appraisal of Farm Buildings"—J. C. Wooley, agricultural engineer, University of Missouri, and H. J. Barre, agricultural engineer, Iowa State College

Second Day—Tuesday, December 5

Forenoon Session — 9:30 - 11:30

PAPER: "A Study of Pressures Exerted by Ear Corn in Cribs"—Wallace Ashby, chief, division of structures, Bureau of Agricultural Engineering, U. S. Department of Agriculture (Tentative)

REPORTS of technical committees

Afternoon Session — 2:00 - 4:00

SYMPOSIUM: "The Cooperative Farm Building Plan Service" — Discussion led by R. C. Miller, professor of agricultural engineering, Ohio State University

A.S.A.E. and Related Activities

A.S.A.E. Land Reclamation Meeting

THE Land Reclamation Division of the American Society of Agricultural Engineers will hold a one day round table conference—Wednesday, December 6, at The Stevens, Chicago—for the discussion of subjects which are of timely interest and concern to this group of agricultural engineers. These subjects will include the gully control work of the Civilian Conservation Corps, federal and state soil erosion control programs, and possibly irrigation in humid areas. Arrangements have been made for a representative of the U.S.D.A. Forest Service to present the administrative phases of conservation work. The program of the conference is being arranged by Lewis A. Jones, vice-chairman of the A.S.A.E. Land Reclamation Division.

North Atlantic Section Announces Program Features

THE yearly meeting of the North Atlantic Section of the American Society of Agricultural Engineers, usually held in October, is scheduled for January 17 to 19, and will be held at Harrisburg, Pennsylvania. These dates coincide with the annual Pennsylvania Farm Show, an event that each year draws tens of thousands of visitors. The main purpose of scheduling the meeting of the Section at that time was to give those attending an opportunity also to visit the Farm Show.

The program of the Section meeting will start with a session on Wednesday afternoon, January 17, which will feature such subjects as fruit washing, farm refrigeration and storage, and the terracing of farm lands of the East. For the evening of the same day, several round table discussions will be arranged to provide for the particular group interests of those who attend the meeting.

The forenoon session of Thursday, January 18, will feature largely outstanding speakers on agricultural subjects of a more or less general nature, with particular reference to their relationship to agricultural engineering. The afternoon session of the same day will be devoted to papers dealing with such subjects as farm fire prevention and protection, lightning protection, and air conditioning. On Thursday evening will be held the usual dinner which in times past has been an important and climactic event in the meetings of the North Atlantic Section. The dinner for this coming meeting promises to fully uphold its past reputation.

The program for the forenoon session Friday, January 19, will be devoted to the general subject of farm power and machinery, including such matters of timely interest as Diesel engines for farm power units, pneumatic rubber tires for tractors and other farm machinery, potato machinery, corn harvesting, and natural and artificial curing of forage. This session will officially close the meeting, and on the afternoon of the same day arrangements are being made for the groups to visit the Farm Show.

The meetings will be held at the downtown Y.M.C.A., at North and Front Streets. Inasmuch as there will be a great many people in Harrisburg during that week attending the Farm Show, it is urged that those who plan to attend this meeting, write promptly for room reservations. The rates at the Y.M.C.A. for non-members of that organization range from \$1.25 to \$1.75 per person, and reservations should be made direct with Mr. J. M. McKee, 707 Telegraph Building, Harrisburg, Pennsylvania. The cost of hotel accommodations range from \$2.50 to \$3.00 a day, and The Harrisburgher and Penn-Harris hotels are within a few blocks of the Y.M.C.A.

Reduced railroad fares (one and one-half fare per trip) will be effective for persons residing in New York, New Jersey, Delaware, Maryland, Virginia, and West Virginia. Those attending the meeting from the states named should write Mr. McKee for a reduced fare certificate which they can present when purchasing their tickets to the meeting.

Necrology

OTTO BISMARCK STICHTER (Aff. A.S.A.E.) passed away at his home in Albany, New York, July 2. He attended his first A.S.A.E. meeting at Cornell University, Ithaca, N. Y., in April 1925, at which time the North Atlantic Section of the Society was organized. He was elected to membership in the Society later the same year.

Mr. Stichter was born at Washington, Iowa, in July 1876, and for thirty-five years was connected with the Louden Machinery Company in both the manufacturing and sales branches of the business. At the time of his passing he was manager of the company's branch at Albany, New York, a position he had held for many years. He was a veteran of the Spanish-American war, serving as sergeant of Company B of the 50th Iowa Volunteer Infantry.

Mr. Stichter was a most active and enthusiastic worker in the activities of the North Atlantic Section, and for several years rendered most effective service as secretary-treasurer of the Section.

About ASAE Members

L. G. Heimpel, assistant professor of agricultural engineering, Macdonald College, McGill University, is author of reprint No. 18 of that institution, entitled "Ventilation of Dairy Barns in Quebec."

R. Earl Storie, assistant soil technologist, California Agricultural Experiment Station, is author of Bulletin No. 556, entitled "An Index of the Agricultural Value of Soils," recently issued by that station.

New ASAE Members

Samuel Maxwell Beane, milk tester, Fauquier Dairy Herd Improvement Association, Catlett, Virginia.

John P. Billingsley, high school instructor, King George, Virginia.

Wayne H. Lowry, agricultural engineer, C.C.C. Camp 57-E, Albany, Missouri.

Evelyn H. Roberts, research specialist in home economics, State College of Washington, Pullman, Wash. (Mail) Home Economics Building.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the October issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Frederick A. Brooks, associate agricultural engineer, University of California Agricultural Experiment Station, University Farm, Davis, Calif. (Mail) Box 293.

Julian L. Schueler, chief metallurgist, Continental Steel Corporation, Kokomo, Ind.